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B-Level

Sonic log aids producers 65
Oil search in So. America 78
How to unitize in a hurry 104
Texas coast's new gas play 113
Industry earnings improve 118

SEPTEMBER
1959

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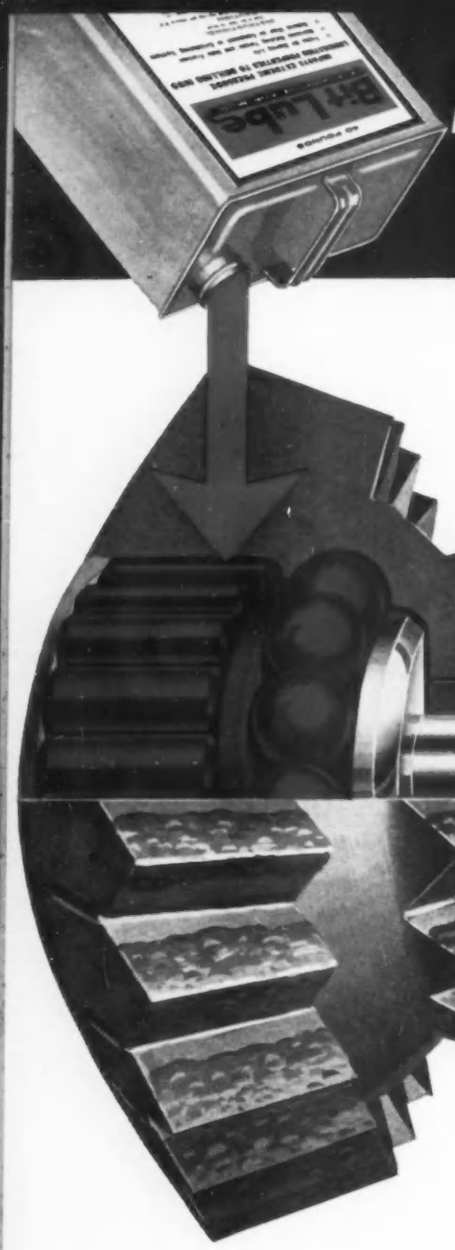

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WATER	40	7⅞"	4936-7270	379	45-60,000	55-60

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HOUSTON, TEXAS

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VOLUME 149, NO. 4 SEPTEMBER, 1959

WORLD OIL

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SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

CURRENT OUTLOOK

Looking ahead ... 13
Editorial page ... 17
Petroleum trends in the United States ... 25
The Changing Panorama ... 25
Drilling activities ... 28
How to unitize in a hurry
Russell J. McLellan ... 104
Oil industry investments jump 32.8% in five years ... 108
New fields spur gas search along Texas Coast
Don E. Lambert ... 113
Earnings remain good after increasing in first half
L. J. Logan ... 118

EXPLORATION

Silurian rocks have oil and gas potential in Southwest Michigan
Garland D. Ells ... 88

DRILLING

New formation sampler reduces operational costs
Walter E. Hyde ... 63
How to combat lost circulation while cementing (Part 1)
A. J. Willis and R. A. Wynne ... 69
How to select and maintain drilling generators
O. J. Graham ... 83
Casing failures: types, detection, cures, prevention
Larry C. M. Darling ... 99

PRODUCTION

Sonic log proves valuable porosity tool in Oklahoma and Kansas
H. E. Pickhardt and L. M. Holley ... 65
How to improve your gas lift installations (Part 2)
H. W. Winkler ... 73
How to produce high pour point, waxy crude
J. J. Dremer ... 94

INTERNATIONAL

Vast marine basins being explored in South America (Part 1)
Carl A. Moore ... 78

NEW EQUIPMENT

What's new in equipment ... 161
New equipment catalogs and literature ... 174

DEPARTMENTS

A QUICK LOOK at this issue ... 4
Practical operating hints ... 42
Men in the industry ... 127
Who's meeting where ... 135
Industry association news ... 138
News of service and supply men ... 145
Squeaks from the bullwheel ... 154
Classified advertising ... 156
Trading post ... 156
New books ... 158
Advertisers' index ... 176

Want to save time and money? Be sure to read "Practical Operating Hints" on Page 42

Turn the page for a Quick Look at this issue ➧

WORLD OIL published every month except semi-monthly in February and August. Second class postage paid at Houston, Texas.

a Quick Look at this issue . . .

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first

☐ **New formation sampler reduces operational costs . . .** A new continuous retrievable sampler is presently being used to evaluate penetrated formations. The device may be used without pulling the drill string, thus eliminating round trip time and hole conditioning time prior to running a test. The tool is assembled as an integral part of the drill string with only one moving part. For a complete description of this new operation . . . . . Page 63

☐ **Sonic log proves valuable porosity tool . . .** The sonic log has become established as a successful logging tool in Oklahoma and Kansas. Accurate porosity values are obtained by use of the linear relationship between formation porosity and interval transit time. Freedom from statistical variations and independence of mud type and hole size are added advantages. Particular applications of the technique to the Mid-Continent area are demonstrated by actual field examples . . . . . Page 65

☐ **How to combat lost circulation while cementing (Part 1) . . .** The problem of lost circulation while cementing has led to the development of several new cement additives. For an informative description of the properties of various types of cement that are now being used, their perforating qualities, plus the different methods used to combat lost circulation while cementing . . . . . Page 69

☐ **How to improve your gas lift installations (Part 2) . . .** A surface closing pressure analysis is used to determine the operating valve in many intermittent gas lift installations using casing pressure operated valves. An important part of this analysis is determination of the surface closing pressures from the closing pressures at depth. For a faster, easier way to construct a family of pressure at depth curves, requiring calculation of only two injection gas pressures . . . . . Page 73

☐ **Vast marine basins being explored in South America (Part 1) . . .** Ancient South American seaways have deposited marine sediments with oil possibilities during every geologic period from Cambrian through Pliocene times, with younger beds often unconformably overlapping much older marine strata. These widespread transgressions are systematically mapped on a regional basis to show their extent and to guide exploration. Many of the oil basins have enjoyed vigorous development and prolific oil production, while others have remained untouched. Maps of the marine basins, a description of South America's geologic setting, plus a highly informative report on South America's oil possibilities are presented . . . . . Page 78

☐ **How to select and maintain drilling generators . . .** Proper selection and maintenance of diesel electric rig generators can mean dollars in your pocket. For the factors you should consider in selecting generators, plus several excellent maintenance suggestions . . . . . Page 83

Coming in October . . .

Another Outstanding Drilling Progress Issue

WORLD OIL'S ANNUAL REPORT on technical and economic progress in the drilling industry has become one of the top reading values in the oil industry. The 1959 report will be no exception. Following is a brief preview of just a few of the articles coming your way in October:

- **"Where Are Oil Industry Economics Heading?"** A timely discussion of five of the drilling industry's most serious problems by five top oil industry leaders.
- **"Winterizing a Rig for Alaska" . . .** How a 20,000-foot rig is equipped for sub-zero temperatures and strong gales.
- **"Technological Advances in High Temperature Muds" . . .** Up-to-the-minute report on the latest drilling fluids and additives.
- **"Increase Penetration Rate with Larger Drill Collars" . . .** A well-known drilling contractor tells why drill collars should be enlarged before increasing the bit size.

☐ **Silurian rocks have oil and gas potential in southwest Michigan . . .** Silurian oil and gas possibilities in Michigan merit more widespread recognition. With some 6,700 square miles of potential territory comparatively unexplored, important new production may be expected from these older and deeper beds. For a comprehensive report on this promising area.....**Page 88**

☐ **How to produce high pour point, waxy crude . . .** Standard Oil Company of California has successfully solved the difficult problem of producing wells which tend to paraffin up at relatively high temperatures. Crude at Red Wash field, Utah (pour point: 95° F, wellhead temperature: 60-70° F) is handled with a minimum of trouble by using bottom hole heaters, rod scrapers, hot oil treatments, line heaters, and electric heating cables to apply heat to the well stream and free deposited paraffin. For complete details on proper use of this equipment.....**Page 94**

☐ **Casing failures: types, detection, cures, prevention . . .** Since casing represents as much as 50 percent of total well costs, it is sound economics to see that adequate pipe is set and cemented in the hole. A complete report on the causes, detection, cures, and prevention of casing failures is presented.....**Page 99**

☐ **How to Unitize in a Hurry . . .** Phillips Petroleum Company recently obtained 75 percent approval from 650 royalty owners in ⅓ the normal time. For complete details on the method used to secure quick approval from such a large number of owners, plus several excellent "keys" to successful unitization.....**Page 104**

☐ **Oil industry investments jump 32.8 percent in five years . . .** From 1954 through 1958, total gross investment in the U.S. oil industry increased from $47 billion to $62.4 billion. Investment in property, plant and equipment increased 37.3 percent to $51.2 billion. For a timely, highly informative report on these and other industry financial trends.....**Page 108**

☐ **New fields spur gas search along Texas Gulf Coast . . .** Although unsuccessful in 10 wildcat attempts, operators are continuing their efforts to prove up a downdip Hackberry trend in Jefferson and Orange Counties. The search was started by the recent discovery of two of the most promising gas condensate fields along the Texas Gulf Coast in 10 years. For a highly informative report on the two fields that started this activity—

Continued on Page 6

Oil Industry In Brief

Here are the latest economic trends, revealed by WORLD OIL *and industrial research.*

On the plus side

Earnings improve. WORLD OIL study of 38 companies shows an earnings increase of 26 percent in first half of 1959 over same '58 period. However, earnings would have to increase another 25 percent to equal 1957 first half earnings . . . **See Page 118.**

Well completions at 18-month high. New well completions in the U.S. averaged 141 wells per day in July, up 10.2 percent over the 128 completions per day in June. July total of 4,366 at month's end was the highest since the end of January 1928 . . . **See Page 28.**

Footage increases. Footage drilled averaged 600,000 feet per day in July, up 11.8 percent over the 536,670 feet per day average in June . . . **See Page 28.**

Markets steadier. Industry's supply-demand picture is improving. July supply of oils was down 505,000 barrels daily from June—to 9.02 million barrels per day. Demand averaged 9.6 million barrels daily during first seven months of 1959—up 4.4 percent over same '58 period . . . **See Page 25.**

Investments hit new peak . . . Gross investment in the U.S. oil industry jumped 32.8 percent, from $57 billion to $62.4 billion in the five-year period, 1954-1958 . . . **See Page 108.**

On the minus side

Rig activity is down. Showing the first drop in five months, the July 31 total of 4,290 active rigs was down 84 rigs or 2 percent from June 30 total. However, total was 5.1 percent greater than the 4,028 rigs reported operating on July 31, 1958 . . . **See Page 28.**

Wildcatting down slightly. Despite 180-well increase to 920 wildcats drilling in July, total wildcatting for first seven months was still 1.3 percent under 5,541 total reported during same 1958 period . . . **See Page 28.**

Tight proration continues . . . In effort to cut excessive stocks, crude production was cut sharply in both July and August. August production in Texas was limited to 9 producing days out of 31, same as July . . . **See Page 25.**

QUICK LOOK *continued*

Port Acres and Port Arthur—including drilling costs, typical drilling and completion programs, and a description of the activity in the area..... **Page 113**

☐ **Earnings Remain Good After Increasing in First Half . . .** Oil industry profits in the first half of 1959 were 26 percent larger than in the same period of 1958. They would have had to be another 25 percent higher, however, in order to come up to those in the first half of 1957. In this year's first quarter, earnings were up 20 percent over a year earlier, and in the second quarter they showed an increase of 31 percent. The trend of earnings remains favorable. However, profits in the third and fourth quarters of 1959 will show smaller increases, for recovery from the recession was already under way in last year's third and fourth quarters..... **Page 118**

Why You Should Save Your Gas Lift Series

The first two parts of this highly informative seven-part series have been enthusiastically received by operators, engineers and production foremen. In fact, they say the articles are a *must* for their production files.

Check the following upcoming subjects, written by a top authority on gas lift installations, and you will have ample proof that this series is tailor-made to save you time, money and effort:

In this issue **. . .** A handy method for constructing pressure at depth curves for specific data, on Page **73.**

October **. . .** A new simplified gas lift valve spacing chart that allows you to read valve setting depths directly from a graph.

November **. . .** Method for estimating injection gas requirments for intermitting gas lift wells (dual and single completions).

December **. . .** How to estimate gas requirements for intermittent lift.

January **. . .** The purpose and use of flow valve specifications.

February **. . .** How to hook up surface controllers for special gas lift applications.

Plan now to save these articles for your production files.

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WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing industry.
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PIPE LINE INDUSTRY and THE PIPE LINE CATALOG for the oil and gas pipe line industry.

Indexed by Industrial Arts Index and Engineering Index

Looking Ahead

Steel strike cuts into 1959 demand . . . Excessive oil stocks, eased considerably by sharp production cutbacks in recent months, again may plague the industry. Reason: Prolonged steel strike will reduce industrial demand—particularly for heavy fuels. Predictions now are for at least a two-month strike, long enough to create new weaknesses in product prices in fourth quarter.

One bright spot in strike picture: Oil country goods are in adequate supply, and should remain so through October. However, some smaller operators will feel pinch much sooner.

Now: Accurate gravity measurement from airplanes . . . A Houston, Texas, geophysical firm has measured gravity accurately from an airplane for the first time. Long-sought goal recently was achieved over California's Imperial Valley using new type gravity meter which includes devices that offset and calculate plane's motion. Developer says method should be particularly helpful in identifying geological structures in remote areas.

Swan Hills—Canada's biggest oil field? . . . Now that muskeg vehicles have reduced transportation problems, Alberta's Swan Hills area may replace Pembina as Canada's largest oil field. Canadian Petroleum Association reports field has more than one billion barrels of recoverable oil. About $5 million will be spent this year on 13 deep tests in the 31,000-acre field.

Russia isn't the only country that builds 'em big . . . A Canadian drilling company recently drilled 600 feet of surface hole at Marble Mountain using 20-ton, 56-foot long, 16½-inch drill collar. Used to prevent crooked hole in hard-to-drill Alberta foothills, the $25,000 collar is believed to be the world's largest. Biggest ever used in the U.S. is said to have been 11¼-inch. Only ⅞ of a degree of deviation was reported at final depth.

Shell Oil Company is using a specially designed bit to drill two 450-foot shafts (each 52 inches in diameter) in St. Louis limestone. Reason: Shell is digging out the largest man-made LPG storage cavern in the U.S. on its Wood River, Illinois property. Huge bit has 15 cones, drills about 30 feet per day in surface rock, about 9 feet per day in limestone.

Another company enters political picture . . . A program "to inform the public on the conduct of our business and the views we hold on important public affairs" has been initiated by Esso Standard. Esso has set up public affairs committee to carry out two-phase plan to (1). Keep employes informed about political and public affairs. (2). Encourage employes to exercise political rights and privileges.

Recently Gulf Oil Corporation announced a similar program to accomplish much the same purpose. (See editoral, Page 17).

Eisenhower vetoes Alaska leasing bill . . . Big business received another setback when Eisenhower vetoed bill that would have increased Alaska's oil and gas acreage limitations to 600,000 acres.

Reasons given by Interior Secretary Seaton: Bill would permit big companies to obtain most of Alaska's oil and gas acreage, would retard development, and would eventually cost Alaska as much as $200 million in future revenues.

DOWN TIME
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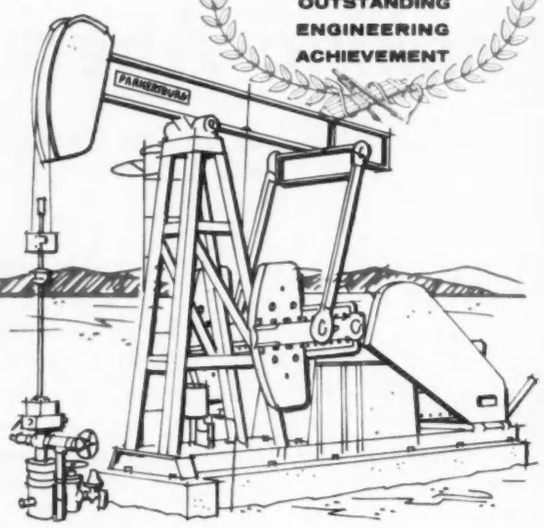
RUGGEDNESS

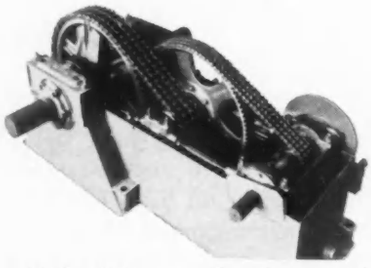
ANOTHER PARKERSBURG OUTSTANDING ENGINEERING ACHIEVEMENT



Minimum maintenance with maximum "payout" . . . that's the record achieved by the more than 20,000 Parkersburg Chain-Driven Pumping Units now in operation throughout the world. Of these, many have been operating dependably and economically for some 24 years. Excellent for service in cold climates. Also available are wide-base or portable-type units ideal for use with timber or gravel foundations, or as economical test units.

SPLIT-TYPE CASE

Totally enclosed welded steel housing has lightweight cover, easily removed by loosening just two bolts . . . a one-man operation. Adjustment of crank weights can also be accomplished easily and safely by one man.



RUGGED CHAIN REDUCER

High-efficiency roller chains and tapered roller bearings are designed for heavy-duty oil-well pumping service. Chains are set at the factory, normally require no adjustment for several years. If necessary, a simple on-the-spot adjustment will maintain chain tightness.

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Chains are multiple-strand with extra-heavy side plates . . . operate in lightweight oil bath the year round. Operation is permanently quiet . . . if repairs are needed, any part can be individually and promptly replaced in the field.

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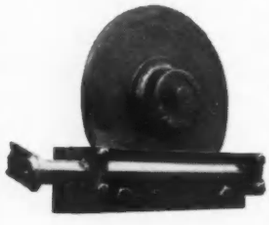

These disc brakes are a safety feature which eliminates accidents and lost man-hours. Positive on-off lock action . . . no dangerous in-betweens. No slippage or stretch . . . operator is never off-balance when stopping or starting the unit.

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Politics is everybody's business

A new force is emerging to counter the creeping sickness of excessive government control over industry. That force is industry itself.

Admitting such efforts have long since been overdue, several companies have decided to shake loose their political handcuffs and take positive action to stop the growing trend to stifle free enterprise. This action, if the public can only be made to realize its significance, may well determine the paths our national economy will follow in the future.

An excellent example of the new force is Gulf Oil Corporation's recently adopted program. Recognizing that we have a heritage to save or to lose, Gulf has undertaken a non-partisan political education program that will underscore the importance of individual participation in politics.

The program begins with the local community where the ballots are cast and public officials elected. It includes three phases:

1. Local and regional Political and Legislative Activity. It is in this area that political supervisors function. They have but one aim: *What is good for a community or region must be good for Gulf.*

These regional representatives, chosen because of their knowledge of the company, industry and area, are equipped with a training program that will enable them to train some of the district managers in the marketing, transportation and production departments. These men will be instrumental in carrying out the program.

2. National Legislative Activity. A Gulf office is being established in Washington staffed by a legislative analyst who also will be a registered lobbyist. Also, a political writer will serve as public relations representative in Washington.

3. Political Information and Education. This activity includes a bi-weekly newsletter from Washington summarizing all legislative activity that pertains to the oil industry. Company publications are being used to explain the program.

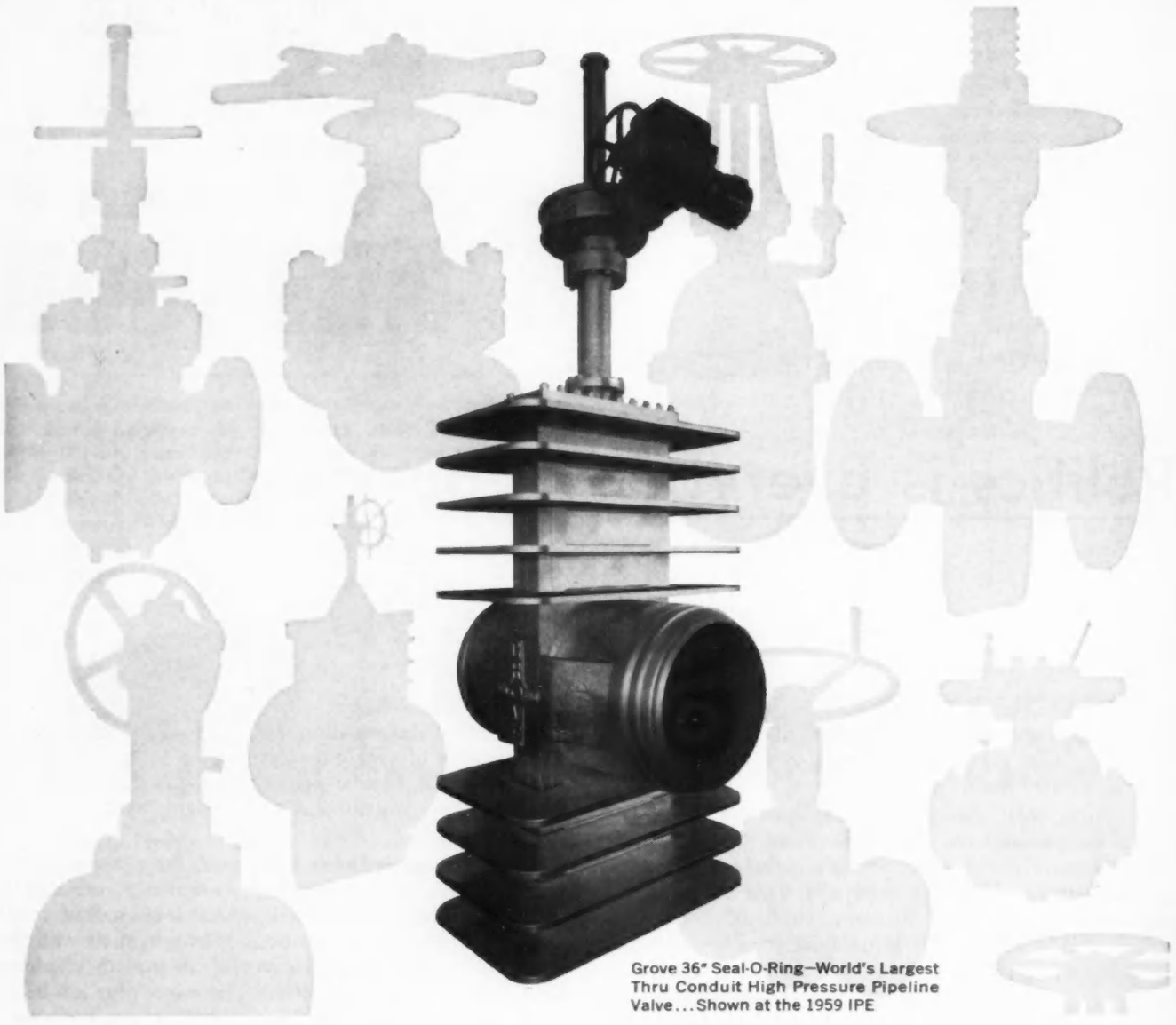
The program is being conducted on a strictly non-partisan basis. Recognition of particularly outstanding civic or political contributions by employes will be made in the company's publications. Consideration will be given to the granting of leaves of absence to employes who may be elected to office. The wives also are being encouraged to become active in carrying out the objectives of the program.

In short, Gulf's program recognizes that maintaining a just and sound government of the people will have to become a private citizen's do-it-yourself effort. For it is only where the votes are cast that a political renaissance can begin.

True, political action on the part of industry probably will intensify the clamor of self interests that big business and free enterprise must be controlled, that industry should be cut down to size, that it has no business in politics. It is almost certain that these interests, in their "truth be damned" anti-free enterprise crusades to win support, will urge the public to ignore completely the simple fact that free competition, unfettered by excessive control, has been the backbone of this nation's economic progress.

One of the most notable of these self interests is big labor. Union leaders have publicly announced an all-out drive to control U.S. politics. Thus, it has become important—even imperative—that counteractive efforts be made to insure government representing all of the people, rather than the selfish interests of a few.

No better effort could be made to achieve this goal than Gulf's program to make politics everybody's business.



Grove 36" Seal-O-Ring—World's Largest Thru Conduit High Pressure Pipeline Valve... Shown at the 1959 IPE

We're being imitated!

The Tulsa Show proved it. And we're glad because imitation, it's said, is the sincerest form of flattery. We enjoyed the talk about NEW Floating Seats; REVOLUTIONARY "O" Rings; AMAZING Pressure Seals and HIGHLY ADVANCED Non-Wedging Action . . . since we've had all of these things (and more) since 1953.

These "brand new" engineering-design features have been the reasons why today, Grove sells the major share of all large pipe line valves in the world. More and more valve users have recognized the operating advantages of Grove's Seal-O-Ring design. And judging from all of the "news" in Tulsa, our competition has, too.

But, imitating a design is one thing; duplicating Grove's experience or patented construction is quite another.

Grove valves—with full thru conduit; an effective metal to metal primary seal plus "O" ring cleaning and sealing action—have been proven in over 6 years' use. The "O" rings, manufactured in Grove's own rubber plant, from Grove's own formula, are completely protected in an over-sized groove. No danger of cutting or abrasion resulting from gate action. Heavy mechanical springs keep the seats in line all the time. And you never lubricate . . . See your Grove man soon. Get all the facts.

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Industry's situation continues to improve

Markets grow steadier as surplus supplies are eliminated. Crude production and imports were reduced sharply in July. Demand lately has not been as strong as in earlier months

IMPROVEMENTS in the oil industry's supply-demand situation continued in August, following the betterment that occurred in July.

The recent favorable trends have been established with benefit of the sharply reduced crude oil production allowables in Texas in both July and August.

Also helping to bring supply down in line with market requirements has been a large reduction in imports of both crude and products.

Featuring statistics of July was a sharp reduction in crude oil stocks, which contrasted favorably with the similarly sharp increase in crude stocks in June. The July reduction almost canceled the sharp June increase.

An effective curbing of crude production was continuing in August, with Texas fields limited to 9 producing days out of 31 in the month, as in July.

Demand. In contrast with the sharp gains in demand in the early months of this year over last year, there have been only moderate increases and some decreases lately. In July 1959 the total demand for all oils was less than in July 1958, though gasoline showed an increase.

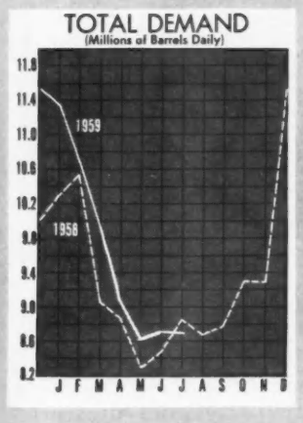
For the first seven months of 1959, total demand was 4.4 percent above the like months of 1958, whereas substantially higher gains were recorded earlier this year.

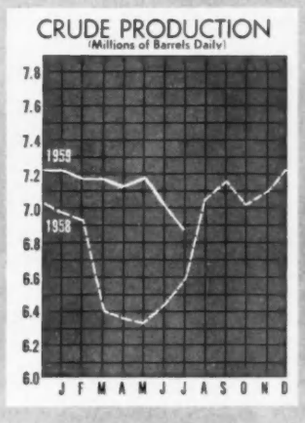
In July 1959 total demand averaged 8,703,000 barrels daily. That was a little less than in June and 167,000 barrels daily or 1.9 percent less than in July of last year. Exports of 250,000 barrels daily were down 63,000 daily or 20 percent from July last year. Domestic demand of 8,453,000 daily was 104,000 barrels or 1.2 percent under July 1958.

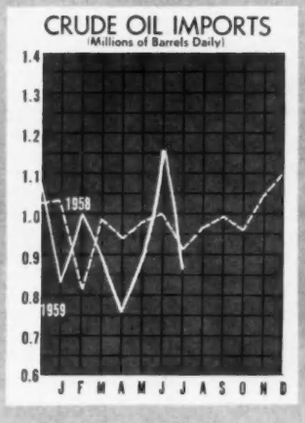
Total demand for gasoline averaged 4,436,000 barrels daily in July 1959, up 133,000 barrels or 3.1 percent over July 1958. Kerosine demand was up 6.1 percent. Distillate fuel oil demand was off 12.6 percent in July, after having shown increases previously. Residual fuel oil demand was down 7.1 percent from last year, in contrast with sharp increases in earlier months.

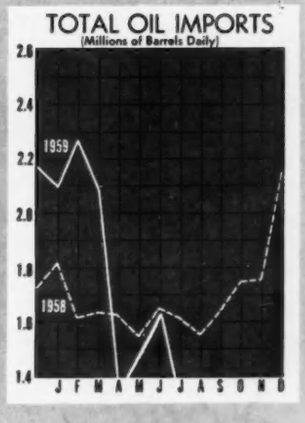
First 7 months. Total demand for all oils averaged 9,602,000 barrels daily in the first seven months of 1959. That was an increase of 405,-

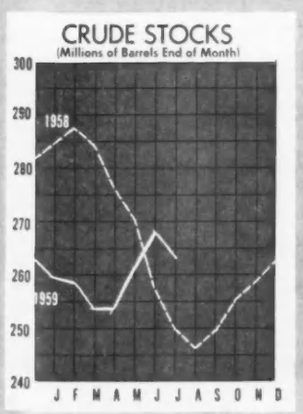
Petroleum Trends...

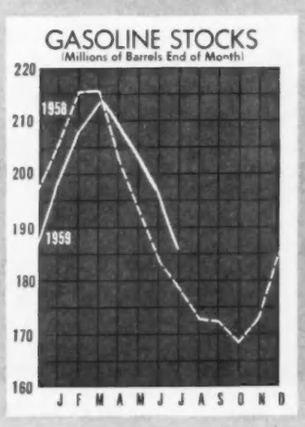


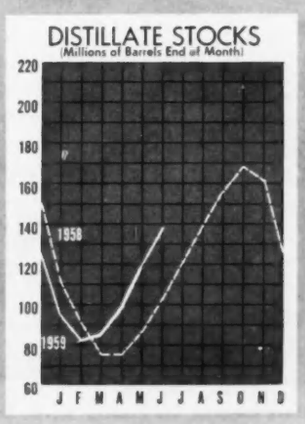


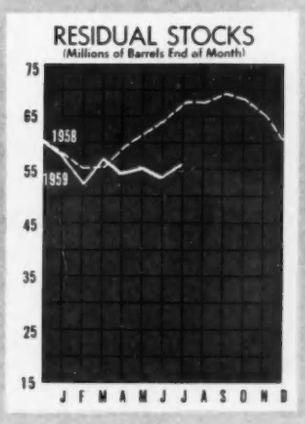






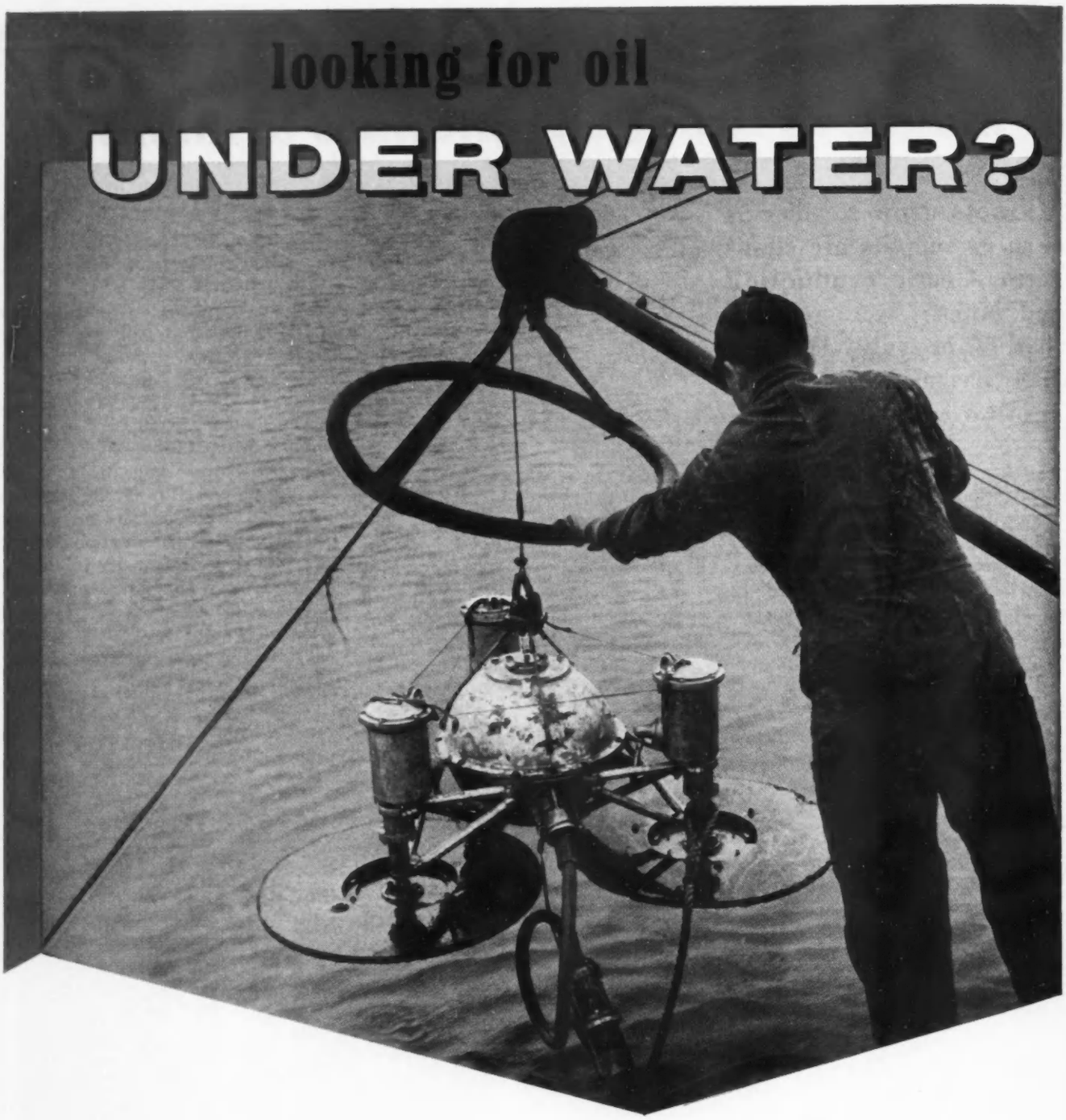






looking for oil

UNDER WATER?



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GEOPHYSICAL SERVICE INC.
100 EXCHANGE PARK NORTH • DALLAS 35, TEXAS

U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	July 1959	July 1958	% Diff.	June 1959	January-July 1959	January-July 1958	% Diff.
DEMAND							
All Oils, Total Demand	8,703	8,870	— 1.9	8,737	9,602	9,197	+ 4.4
Domestic Demand	8,453	8,557	— 1.2	8,487	9,351	8,925	+ 4.8
Export Demand	250	313	—20.1	250	251	272	— 7.7
Gasoline, Total Demand	4,436	4,303	+ 3.1	4,350	4,071	3,900	+ 4.4
Distillate, Total Demand	1,098	1,256	—12.6	1,162	1,874	1,850	+ 1.3
Kerosine, Total Demand	191	180	+ 6.1	186	300	310	— 3.2
Residual, Total Demand	1,221	1,315	— 7.1	1,378	1,681	1,498	+12.2
Other Oils, Total Demand	1,757	1,816	— 3.2	1,661	1,676	1,639	+ 2.3
CHANGE IN STOCKS							
All Oils, Change in Stocks	+319	+ 81	.....	+790	+185	—301	.....
NEW SUPPLY							
Total New Supply	9,022	8,951	+ 0.8	9,527	9,788	8,895	+10.0
Domestic Production, Total	7,701	7,341	+ 4.9	7,864	8,001	7,259	+10.2
Crude Oil	6,836	6,571	+ 4.0	7,002	7,130	6,480	+10.0
Natural Gas Liquids	865	770	+12.3	862	871	779	+11.8
Imports, Total	1,321	1,610	—18.0	1,663	1,787	1,637	+ 9.2
Refined Products	460	742	—38.0	494	846	708	+19.5
Crude Oil, Total	861	868	— 0.8	1,169	941	929	+ 1.3
Crude, East Coast	624	692	— 9.8	906	733	760	— 3.6
CRUDE RUNS							
Crude Runs to Stills	7,935	7,554	+ 5.0	7,993	8,036	7,462	+ 7.7
Domestic Crude	6,909	6,687	+ 3.3	6,949	7,085	7,085	+ 8.2
Foreign Crude	1,026	867	+18.3	1,044	951	916	+ 3.8

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. July 1959	TOTAL IN U.S. July 1958	TOTAL IN U.S. % Diff.	TOTAL IN U.S. June 1959	EAST OF CALIFORNIA July 1959	EAST OF CALIFORNIA July 1958	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA June 1959
All Oils	819.9	776.0	+ 5.7	810.0	.....	.....	.....	.....
Crude Oil	263.7	246.6	+ 6.9	268.1	227.7	203.1	+12.1	233.9
Gasoline	186.2	180.7	+ 3.0	195.9	159.3	155.7	+ 2.3	167.0
Distillate Fuel Oil	139.8	119.4	+17.1	119.7	125.4	105.8	+18.5	106.5
Kerosine	29.3	25.7	+14.0	27.4	28.9	25.3	+14.2	27.0
Residual Fuel	55.8	66.5	—16.0	54.2	29.0	34.0	—14.7	28.1
Other Oils	145.1	137.1	+ 5.8	144.7	....	....	.....	....

U.S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average for Month July 1959	July 1958	% Diff.	June 1959	Total, January-July 1959	1958	% Diff.
Alabama	16.2	19.2	— 15.6	16.1	2,937	3,430	— 14.4
Arkansas	81.2	78.7	+ 3.2	81.0	16,773	16,788	— 0.1
California	851.4	846.4	+ 0.6	847.9	179,185	184,085	— 2.3
Colorado	124.3	131.5	— 5.5	126.0	26,743	28,582	— 6.4
Florida	1.1	1.2	— 8.3	1.2	248	263	— 5.7
Illinois	217.0	229.1	— 5.3	213.0	45,626	47,559	— 4.1
Indiana	31.5	33.3	— 5.4	31.1	6,986	6,856	+ 1.9
Kansas	309.6	318.6	— 2.8	325.1	69,729	67,205	+ 3.8
Kentucky	88.7	46.2	+ 92.0	76.5	16,014	9,296	+ 72.3
Louisiana	977.8	828.2	+ 18.0	968.0	202,268	174,606	+ 15.8
North Louisiana	115.3	117.9	— 2.2	115.6	25,491	24,416	+ 4.4
South Louisiana	862.5	710.3	+ 21.4	852.4	176,777	150,190	+ 17.7
Michigan	27.1	25.5	+ 6.3	25.5	5,553	5,396	+ 2.9
Mississippi	131.8	107.6	+ 31.8	130.7	26,556	20,991	+ 26.5
Mo.-So. Dak.-Tenn.	0.4	0.3	+ 33.3	0.3	36	75	— 52.0
Montana	81.4	79.3	+ 2.6	78.7	17,116	16,331	+ 4.8
Nebraska	62.7	57.8	+ 8.5	63.4	12,864	11,411	+ 12.7
Nevada-Wash.-Alaska-Ariz.	0.5	0.1	+400.0	0.5	100	24	+316.7
New Mexico	293.1	282.3	+ 3.8	293.8	61,017	55,917	+ 9.1
Southeast	258.3	254.2	+ 1.6	255.0	53,252	52,079	+ 2.3
Northwest	34.8	28.1	+ 23.8	38.8	7,765	3,838	+102.3
New York	5.3	3.1	+ 70.1	5.4	1,133	1,224	— 7.4
North Dakota	38.7	44.2	— 12.5	38.5	9,697	8,689	+ 11.6
Ohio	13.9	18.1	— 23.2	14.1	3,164	3,687	— 14.2
Oklahoma	517.2	561.3	— 7.9	543.1	116,978	116,719	+ 0.2
Pennsylvania	15.4	19.1	— 19.4	15.7	3,407	4,032	— 15.5
Texas	2,480.8	2,418.8	+ 2.6	2,641.0	590,663	514,903	+ 14.7
Dist. 1: South Central	44.8	43.5	+ 3.0	46.1	9,699	9,672	+ 0.3
Dist. 2: Middle Gulf	105.8	103.9	+ 1.8	116.8	25,943	22,885	+ 13.4
Dist. 3: Upper Gulf	356.2	358.2	— 0.6	384.6	84,264	77,791	+ 8.3
Dist. 4: Lower Gulf	175.4	182.5	— 3.9	186.1	41,969	38,000	+ 10.4
Dist. 5: East Central	28.2	26.6	+ 6.0	29.3	6,567	6,079	+ 8.0
Dist. 6: Northeast	236.1	234.7	+ 0.6	256.2	58,396	51,268	+ 13.9
Dist. 7-B: North Central	128.3	124.9	+ 2.7	132.2	35,908	27,952	+ 28.5
Dist. 7-C: West Central	116.4	126.1	— 7.7	125.3	28,297	26,921	+ 5.1
Dist. 8: West	976.1	909.9	+ 7.3	1,050.5	233,051	185,162	+ 25.9
Dist. 9: North	206.6	186.7	+ 72.1	207.0	44,151	40,958	+ 7.8
Dist. 10: Panhandle	106.8	104.0	+ 2.7	106.9	22,719	22,555	+ 0.7
Utah	114.1	89.0	+ 28.2	115.4	23,441	9,871	+137.5
Virginia	.....	.....	.....	.....	3	4	— 25.0
West Virginia	5.7	6.2	— 8.1	6.2	1,240	1,273	— 2.6
Wyoming	348.7	325.9	+ 7.0	343.6	72,178	64,502	+ 11.9
Total, U.S.	6,835.4	6,571.0	+ 4.0	7,001.8	1,511,655	1,373,719	+ 10.0

Sources for above 3 tables: Bureau of Mines monthly reports, except last two months based on API and B. of M. weekly reports and WORLD OIL estimates, and all Texas district data from API.

000 barrels or 4.4 percent over the like period of 1958. Exports were down 21,000 barrels daily. Domestic demand was up 426,000 barrels daily or 4.8 percent.

Total demand for gasoline averaged 4,071,000 barrels daily in the first seven months of 1959. That was 171,000 barrels or 4.4 percent above January-July last year. Distillate fuel oil demand was up 24,000 barrels daily or 1.3 percent for this year's first seven months. Kerosine demand was off 10,000 barrels daily or 3.2 percent. Residual fuel oil demand showed the largest gain among the major products. It averaged 1,681,000 barrels daily, an increase of 183,000 barrels or 12.2 percent over last year. Demand for other oils showed an increase of 37,000 barrels daily or 2.3 percent.

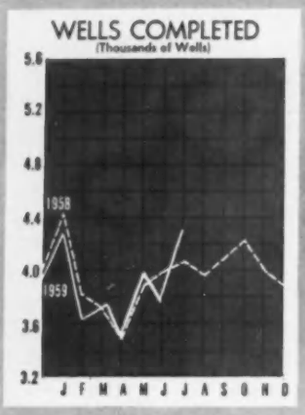
Supply cut in July. Total new supply of oils in July 1959 was cut to 9,022,000 barrels daily, which was only slightly more than supply in July last year. This represented a cut of 505,000 barrels daily from June 1959 supply.

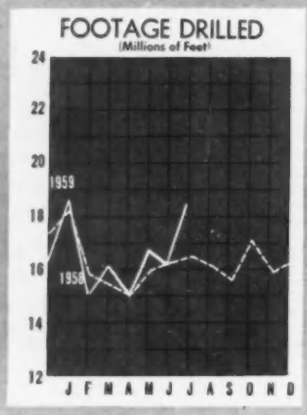
U.S. crude oil production of 6,836,000 barrels daily was 166,000 a day less than in June. Natural gas liquids production was about unchanged. Total imports of 1,321,000 barrels daily were down 342,000 barrels from June, with crude receipts of 861,000 daily down 308,000 barrels and imports of refined products off 34,000 barrels to 460,000 daily.

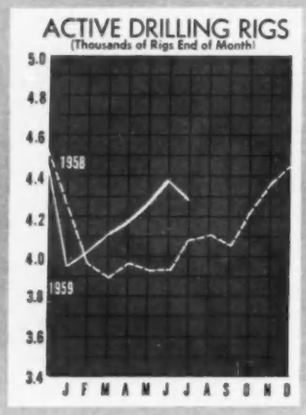
Crude runs to stills averaged 7,935,000 barrels daily in July. They were off 58,000 daily from June but were 381,000 barrels daily or 5 percent above July 1958. For the first seven months of 1959, runs to stills averaged 8,036,000 barrels daily, an increase of 574,000 barrels or 7.7 percent over the like period of 1958.

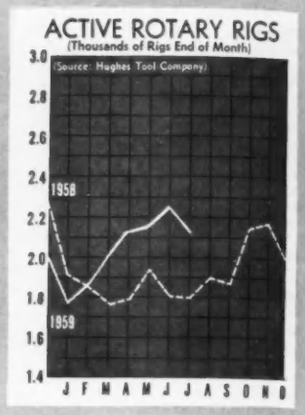
Markets. Oil industry markets have become steadier in recent weeks, with benefit of the elimination of surplus supplies, which previously depressed product prices and the prices of some crudes. Wholesale prices of gasoline were marked up one half cent a gallon around the middle of August in some areas of the Middle West and the Southeast. Further improvement of markets was promised.

Drilling Activities...









Well completions at 18-month high

NEW U.S. WELL COMPLETIONS totaled 4,366 in July, for an average of 141 wells per day. This was the highest total since January 1958 when 4,427 new wells were completed.

The July average also was up 10.2 percent over the 128 new completions per day in June and 2.9 percent over the July 1958 average of 137 wells per day.

However, U.S. rig activity was down 84 rigs or 2 percent on July 31, from the 1959 high of 4,374 rigs operating on June 30. Even so, the July total of 4,290 rigs was 5.1 percent greater than the 4,082 rigs reported operating on the same date in 1958.

The drop in total operating rigs at the end of July followed a four-month upward trend in drilling rig activity.

Footage drilled averaged 600,000 feet per day in July, up 11.8 percent over the 536,670 feet per day average in June. During the first seven months of 1959, footage drilled totaled 116.5 million feet, up 2.6 percent from the same 1958 period.

Summary of U.S. Drilling Activity

ITEM	July 1959	June 1959	SEVEN MONTHS January-July 1959	1958	% Diff.
New Wells Completed:					
Oil	2,175	1,958	14,263	13,939	+ 2.3
Distillate	63	69	476	438	+ 8.7
Gas	387	331	2,286	2,433	— 6.1
Service	58	62	447	707	— 36.8
Dry	1,683	1,422	10,385	10,262	+ 1.2
Total Wells	**4,366**	**3,842**	**27,857**	**27,779**	**+ 0.3**
Footage Drilled (Mlns. of Feet)	**18.6**	**16.1**	**116.5**	**113.5**	**+ 2.6**

Summary of U.S. Wildcat Drilling

ITEM	July 1959	June 1959	SEVEN MONTHS January-July 1959	1958	% Diff.
New Field Discoveries:					
Oil	63	63	404	431	— 6.3
Distillate	6	12	56	56	.....
Gas	19	23	145	134	+ 8.2
Total Discoveries	**88**	**98**	**605**	**621**	**— 2.6**
Dry Wildcats	832	642	4,863	4,920	— 1.2
Total Wildcats	**920**	**740**	**5,468**	**5,541**	**— 1.3**
Percent Productive	9.6	13.2	11.1	11.2	.....
Percent Dry	90.4	86.8	88.9	88.8	.....

A "hot" ring helps tame an old enemy

Atomic radiation helps this man do his job.

He's Dr. Hugh Macpherson, one of Standard's research engineers. The "hot" ring he's holding is an ordinary piston ring which has been exposed to atomic radiation.

By installing such radioactive piston rings in a car, our research engineers can use a Geiger counter to measure wear *as it happens* while the car is driven on the highway, in traffic, on hills — in every possible driving situation.

This research technique has taken months off the time needed to test the effectiveness of new motor oils, and it's far more accurate than previous methods.

It's one of the techniques pioneered by Standard's scientists to help defeat an old enemy—wear... to learn what it is, what causes it, how to prevent it.

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In the 1930's, for example, cars could go only 20 to 40 thousand miles before a major overhaul. But with today's motor oils and regular oil changes, your engine can be good for more than 100,000 miles—can, in fact, outlast the car.

By such never-ending research that leads to better products, ***the people at Standard are planning ahead to serve you better.***

OIL'S FIRST CENTURY
BORN IN FREEDOM
WORKING FOR PROGRESS

STANDARD OIL COMPANY OF CALIFORNIA

U.S. Drilling Activity in July and First Seven Months, 1959-1958

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR JULY, 1959 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — July 1959	June 1959	July 1958	Total Footage July 1959	DETAILS FOR JANUARY-JULY: NEW WELLS — 1959	1958	Percent Diff.	FOOTAGE — 1959	1958	WILDCAT DRILLING IN JULY AND FIRST SEVEN MONTHS, 1959-58: DETAILS FOR JULY, 1959 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-JULY — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1959	1958	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down) — July 31, 1959	June 30, 1959	July 31, 1958
Alabama	3	....	....	4	....	7	14	7	59,112	66	45	+ 46.7	591,165	383,387	....	....	....	4	4	....	....	....	20	20	16	13	11	14
Alaska	1	....	....	....	....	1	....	....	12,582	5	....	.....	61,887	.....	....	....	....	....	....	1	....	....	3	4	....	6	4	....
Arkansas	36	....	6	32	....	74	73	65	232,901	464	395	+ 17.5	1,531,449	1,340,536	1	....	2	12	15	2	....	4	63	69	91	37	46	55
California	53	....	3	45	2	103	130	106	484,751	818	885	— 7.6	3,863,006	4,089,131	....	....	....	25	25	1	....	5	153	159	170	145	155	136
Colorado	19	....	5	64	....	88	54	97	433,343	424	478	— 11.3	2,204,755	2,486,373	2	....	1	47	50	13	....	6	215	234	257	64	58	74
Florida	....	....	....	1	....	1	....	2	11,675	4	4	.....	29,026	41,889	....	....	....	1	1	....	....	....	4	4	4	2	2	2
Georgia	....	....	....	....	....	....	....	....	....	1	....	.....	990	.....	....	....	....	....	....	....	....	....	1	1	....	....	....	1
Illinois	87	....	3	86	....	176	178	215	332,278	1,137	1,233	— 7.8	2,479,863	2,825,642	1	....	....	41	42	7	....	....	254	261	313	299	272	282
Indiana	25	....	1	66	....	92	83	82	133,064	492	419	+ 17.4	788,477	690,523	....	....	....	32	32	....	....	1	137	138	110	94	88	102
Kansas	143	....	23	174	7	347	291	321	1,313,577	2,134	2,004	+ 6.5	7,872,794	6,920,024	9	....	2	103	114	81	....	15	549	645	538	302	307	341
Kentucky	138	....	32	91	2	263	255	233	231,305	1,654	1,188	+ 39.2	1,507,722	1,121,634	1	....	....	9	10	7	....	....	47	54	37	195	157	120
Louisiana	162	23	29	146	....	360	299	302	2,766,466	2,119	1,957	+ 8.3	16,660,589	16,042,581	3	2	1	53	59	20	10	5	261	296	322	374	408	337
North Louisiana	69	....	19	58	....	146	110	115	494,094	781	675	+ 15.7	2,794,502	2,590,817	2	....	....	21	23	11	1	....	84	96	85	72	59	95
South Louisiana	93	23	10	88	....	214	189	187	2,272,372	1,338	1,282	+ 4.4	13,866,087	13,451,764	1	2	1	32	36	9	9	5	177	200	237	302	349	242
*Gulf of Mexico	20	6	1	14	....	41	37	41	443,446	272	300	— 9.3	2,770,912	2,865,707	....	1	....	1	2	1	2	2	15	20	26	60	62	42
Michigan	27	....	2	21	....	50	62	42	159,438	310	221	+ 40.3	916,973	655,271	....	....	....	12	12	2	....	....	70	72	73	98	91	69
Mississippi	19	....	4	36	....	59	53	35	564,011	369	212	+ 74.1	3,427,530	1,923,154	....	....	....	23	23	6	....	2	135	143	91	74	72	40
Missouri	....	....	....	3	....	3	3	2	4,925	9	10	— 10.0	9,039	6,272	....	....	....	3	3	1	....	....	6	7	3	....	3	2
Montana	29	....	1	17	....	47	30	18	208,276	187	179	+ 4.5	895,744	983,732	....	....	....	6	6	1	....	....	50	51	76	45	45	46
Nebraska	47	....	....	67	....	114	69	54	680,232	480	369	+ 30.1	2,859,035	2,197,084	6	....	....	36	42	26	....	....	185	211	170	40	47	42
New Mexico	107	....	37	30	....	174	116	166	714,891	972	1,135	— 14.4	3,960,618	5,376,733	5	....	4	21	30	25	1	12	109	147	160	154	176	195
Southeast	52	....	1	16	....	69	64	72	394,786	518	583	— 11.2	2,482,473	2,905,719	3	....	....	12	15	18	....	3	77	98	95	80	91	56
Northwest	55	....	36	14	....	105	52	94	320,105	454	552	— 17.8	1,478,145	2,471,014	2	....	4	9	15	7	1	9	32	49	65	74	85	139
New York	10	....	1	2	6	19	19	21	30,895	131	132	— 0.8	209,180	211,105	....	....	....	....	....	....	....	....	....	....	....	25	25	42
North Dakota	33	....	....	16	....	49	47	50	315,632	279	246	+ 13.4	1,735,564	1,642,211	2	....	....	3	5	11	....	....	39	50	77	39	31	40
Ohio	46	....	20	29	....	95	83	87	259,282	545	568	— 4.1	1,488,942	1,469,030	1	....	....	1	2	5	....	2	8	15	4	216	223	232
Oklahoma	237	6	58	155	3	459	420	568	1,857,096	3,474	4,217	— 17.6	12,390,594	13,230,830	3	1	3	38	45	38	10	21	379	448	443	503	498	442
Pennsylvania	12	....	27	6	6	51	47	73	182,429	334	427	— 21.8	1,130,217	1,266,957	....	....	....	1	1	....	....	2	7	9	14	153	152	219
South Dakota	2	....	....	....	....	2	1	....	16,993	9	3	+200.0	48,256	16,991	2	....	....	....	2	2	....	....	4	6	3	....	1	2
Tennessee	....	....	1	4	....	5	5	2	6,000	35	16	+118.8	42,000	20,425	....	....	....	2	2	....	....	....	14	14	6	....	....	....
Texas	868	34	89	510	28	1,529	1,327	1,531	6,774,219	10,320	10,282	+ 0.4	45,307,490	43,807,507	25	3	6	318	352	145	34	61	1,951	2,191	2,380	1,040	1,137	933
Dist. 1: South Central	52	1	1	34	....	88	67	64	220,151	585	580	+ 0.9	1,491,762	1,420,341	1	....	....	32	33	5	....	1	180	186	213	49	40	36
Dist. 2: Middle Gulf	16	8	12	31	....	67	73	57	414,368	465	418	+ 11.2	2,804,179	2,511,150	....	1	1	25	27	7	9	8	142	166	130	57	57	37
Dist. 3: Upper Gulf	51	12	4	45	....	112	96	94	790,435	699	761	— 8.2	5,040,214	4,848,701	1	....	....	24	25	5	17	6	125	153	205	95	120	72
*Gulf of Mexico	....	....	....	....	....	....	....	....	....	1	8	— 87.5	11,005	62,356	....	....	....	....	....	....	....	1	....	1	6	2	....	1
Dist. 4: Lower Gulf-S.W.	44	13	12	47	1	117	112	109	605,291	782	718	+ 8.9	4,214,347	3,649,377	1	2	....	33	36	9	7	6	223	245	292	95	93	64
*Gulf of Mexico	....	....	....	....	....	....	....	1	....	....	7	—100.0	....	75,300	....	....	....	....	....	....	....	....	....	....	2	....	....	....
Dist. 5: East Central	1	....	2	8	....	11	9	29	50,055	73	114	— 36.0	392,631	407,765	1	....	1	7	9	1	....	1	36	38	69	9	13	16
Dist. 6: Northeast	50	....	3	26	....	79	78	68	411,867	478	495	— 3.4	2,648,182	2,589,805	1	....	....	14	15	6	....	5	87	98	127	52	62	53
Dist. 7-B North Central	77	....	1	84	....	162	199	195	522,592	1,384	1,255	+ 10.3	4,432,025	4,071,788	1	....	....	56	57	39	....	9	405	453	435	100	103	61
Dist. 7-C West Central	43	....	7	31	....	81	68	70	341,764	434	477	— 9.0	1,806,161	2,403,995	6	....	2	26	34	14	....	9	115	138	142	65	75	64
Dist. 8: West	269	....	3	66	8	346	305	351	1,901,799	2,688	2,499	+ 7.6	13,460,928	12,047,000	6	....	....	48	54	36	....	3	273	312	299	294	296	291
Dist. 9: North	190	....	20	119	19	348	228	381	957,535	2,062	2,207	— 6.6	5,855,287	6,431,749	6	....	1	43	50	15	....	2	299	316	389	136	175	153
Dist. 10: Panhandle	75	....	24	19	....	118	92	113	558,362	670	758	— 11.6	3,161,774	3,425,836	1	....	1	10	12	8	1	11	66	86	79	88	103	86
Utah	12	....	....	7	....	19	30	50	94,264	180	272	— 33.8	1,001,882	1,523,464	....	....	....	4	4	2	....	1	39	43	53	43	48	41
Washington	....	....	....	....	....	....	....	....	....	....	4	—100.0	....	20,794	....	....	....	....	....	....	....	....	....	....	3	....	....	....
West Virginia	12	....	40	19	....	71	61	61	183,273	434	486	— 10.7	1,115,532	1,308,277	....	....	....	....	....	....	....	....	....	....	5	213	183	183
Wyoming	47	....	5	45	4	101	86	56	509,985	456	379	+ 20.3	2,374,553	1,839,533	2	....	....	30	32	8	1	7	144	160	109	98	113	84
Others	....	....	....	7	....	7	6	4	15,421	15	13	+ 15.4	41,290	46,051	....	....	....	7	7	....	....	1	16	16	13	18	21	6
Total United States	2,175	63	387	1,683	58	4,366	3,842	4,250	18,588,316	27,857	27,779	+ 0.3	116,546,162	113,487,141	63	6	19	832	920	404	56	145	4,863	5,468	5,541	4,290	4,374	4,082
Total Western Canada	135	....	35	50	....	220	223	245	1,001,000	1,452	1,469	— 1.2	7,104,562	7,275,255	....	....	....	....	....	....	....	....	....	....	....	204	214	229

* Gulf of Mexico wells are included in their respective district totals.

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BAASH-ROSS DIV. JOY

Practical Operating Hints

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

Make a Dope Bucket From Casing and Angle Iron

A dope bucket made from a short piece of casing and angle iron can contribute to convenience and good housekeeping around the rig. Weld a piece of sheet metal to one end of a piece of casing to form the bucket. Then weld on four pieces of angle iron and reinforce to form the legs. The bucket can be easily moved about the rig floor and its handy height is more convenient for the roughneck as a trip is being made.

Protect Drilling Line With Scrap Casing Cut in Half

Scrap casing cut in half and then hinged together can serve as a housing to protect the drilling line from the "hold down" to the drilling reel. This cover can be easily transported with other tubular products used around the rig.

Carry Pipe in Notched Supports on Tank

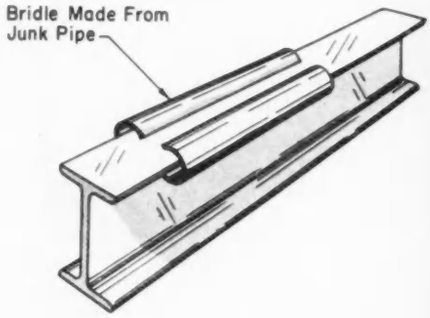
Notched supports on the water supply tank can be used to transport pipe for the water system. This is especially useful on standardized rig hookups where the pipe has been cut to standard lengths and is used for the same application from location to location.

This procedure will speed rigging up since all pipe required for the water system is carried on the tank. It is not necessary to locate new pipe every time supply tanks are set up.

Protect Wire Rope With Simple Bridle Pipe

A simple bridle pipe placed over steel structure used as a hold-down point for wire rope will prevent severe wear on the rope and produce a balanced load on the stressed wire.

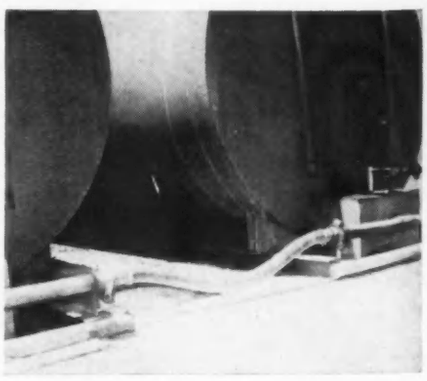
The bridle pipe is made from a small size junk pipe. It is about 12 inches long and cut with a 60-degree opening on the circumference. It can be easily attached to or removed from the narrow edge of any structure beam where rope is bent over for making an anchorage. The protector provides a large flat angle at the contact surface. The bridle pipe diameter depends on size of wire rope used. The rule is:



Rope Diameter	Bridle Pipe Diameter
¼ to 5/16-inch	1-inch
⅜ to ½-inch	1½ inches
⅝ to ¾-inch	2 inches

Use Rubber Hose to Connect Water Tanks

Use a rubber hose to dually connect water supply tanks and simplify placement and installation. The danger of leaks is reduced since the line is never in strain and freezing expansion usually will occur in the hose rather than the pipe where a more serious break could occur. Use hammer unions to speed up rig-up and tear-down operations. Low-pressure hose can be used in a low-pressure system. The lightweight hose is easy to move and can be wrapped around the tank base.



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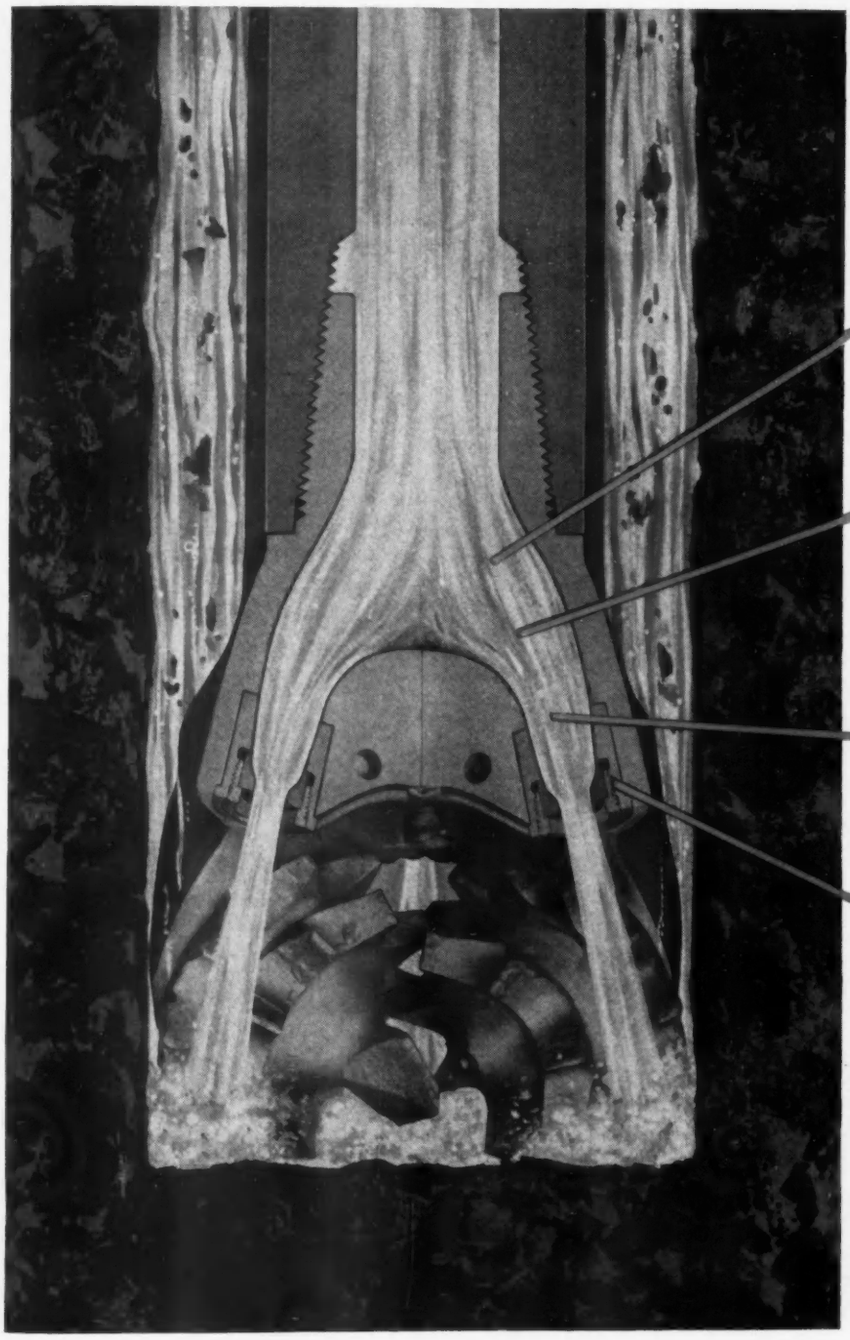

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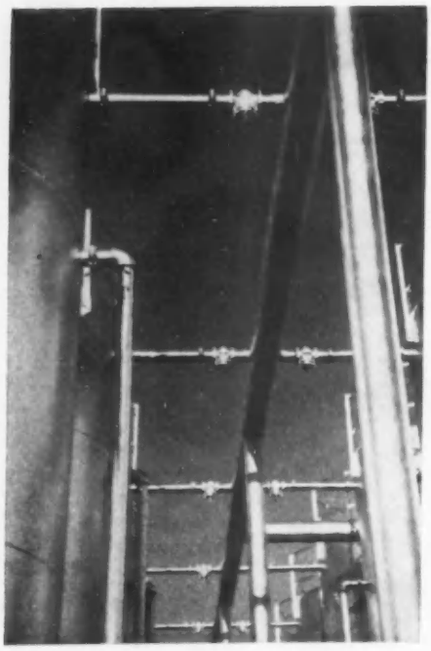
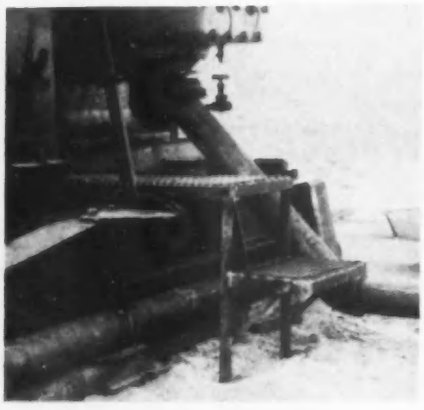


Long-Handled Tee Wrench Operates Elevated Valves

When valves are installed in elevated positions where a walkway cannot be used, the valves can be installed in an inverted position and manipulated from the ground with a long-handled tee wrench.

Except for the lubrication of plug valves, all climbing for the operation of the valves is eliminated by this method of installation.



Provide More Safety With Pumping Unit Steps

These steps provide for safe mounting of the pumping unit deck for checking the engine oil or manipulating the clutch, throttle, or brake when the deck is higher than a safe step.

The steps are made from scrap pipe, angle iron and expanded metal. Discarded tank steps also could be used.

Rack Cross Member Stops Oil Drum from Slipping

This drum rack, which enables one man to handle chemical or oil drums with ease, is made of junk sucker rods. The dimensions of the rack can be varied to suit the dimensions of the drums handled; however, for standard drums, the inside to inside dimensions for height and width are 21 inches and the length is 34 inches. The radius of curvature of the rockers is 12 inches.

A cross member, just above the curved bottom section of the rack, is slid under the drum before tipping, and supports the drum during tipping, thereby eliminating the need for a strap or chain to hold the drum to the rack. (See picture below).

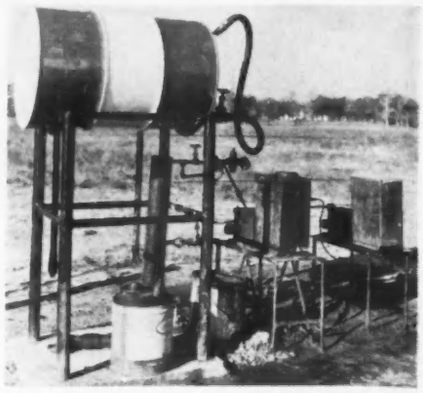
Central Chemical Pump Installation Saves Time

Here is a central chemical pump installation which has proved successful. Included in the installation are a permanent chemical drum rack, a supply gas drip and two chemical pumps with stands.

The drum rack is constructed of 2-inch pipe as shown and is high enough so that lease trucks may load and unload drums directly from the truck bed to the rack. The drum is provided with a length of garden hose for ease in filling the individual reservoirs of the chemical pumps.

The chemical pump supply gas drip has been made from a junk piece of 3-inch pipe and is equipped with inlet and outlet connections at the middle and top, respectively. Chemical pumps are installed on stands which have been built from steel plate and sections of small pipe or sucker rods.

The central location of all chemical treating equipment is very advantageous, since only one gas supply point is required. Also, time is saved since all required equipment can be checked daily by one man by visiting one part of the battery.



Build a Truck Boom With Hydraulic Jack

A lifting device built around a hydraulic jack mounted in the right rear corner of the bed of a lease truck can be useful when disassembling or assembling heavy equipment or loading equipment on the truck.

The top of the jack is bolted into a clevis on the bottom of a boom made from a 2-inch pipe. The bottom of the jack is bolted to a plate on top of a piece of 1½-inch pipe which rests in a well fastened in the corner of the pickup. At the business end of the lift, two bars are attached to the outer end of the base plate and hinged to the 2-inch boom to provide the "lift" when the jack is extended. A hook is fastened to the lifting end of the boom. The boom can be hooked to the side of the truck bed when not in use.

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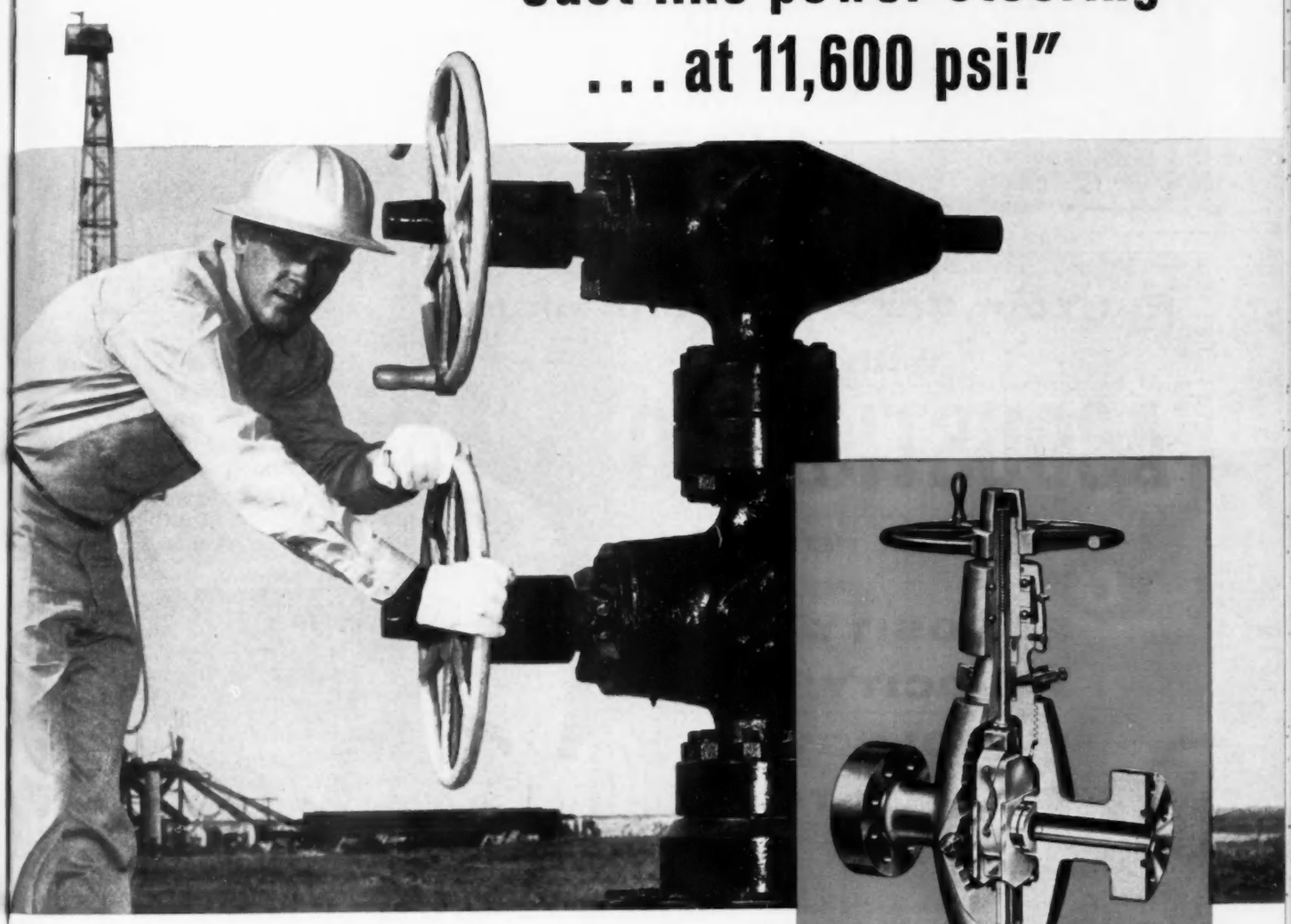

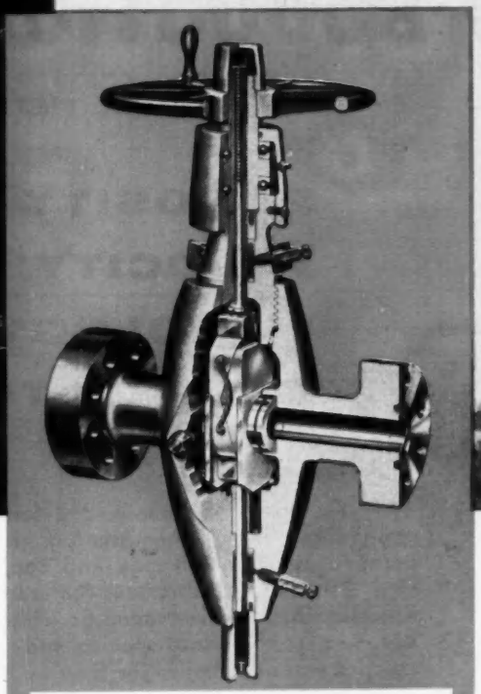

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These valves are the easiest operating high pressure valves ever made.

Only W-K-M Balanced Stem Valves are designed to overcome the heavy thrust loads carried by bearings and threads in single stem valves. A second stem is attached to the bottom of the gate to balance out body pressure that acts against the operating stem. The only loads to be overcome in opening or closing this valve are packing friction and normal operating loads.

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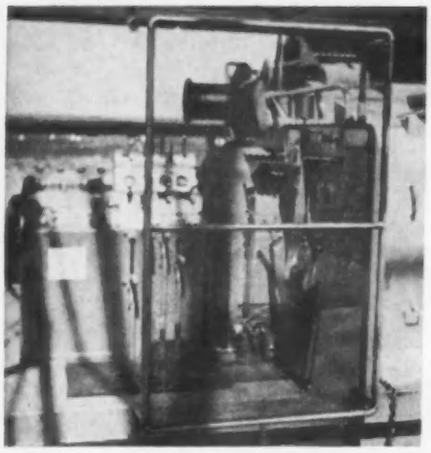


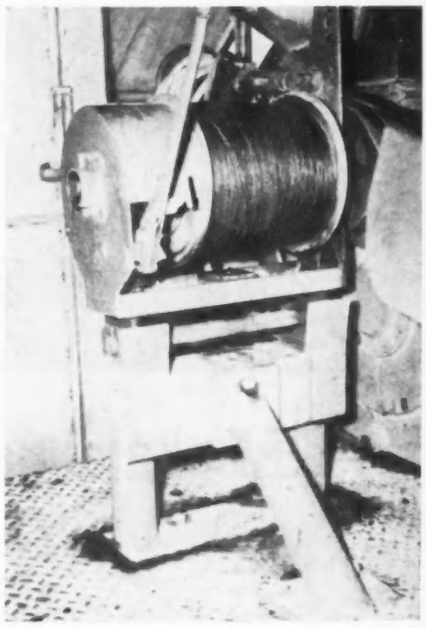
Protect Your Driller With Wire Safety Guard

Build a wire safety guard as a precaution against the spinning chain getting loose and whipping back into the driller's position. Two types of guards can be made as guard against accidents such as this. Make a frame of ¾ to 1-inch tubular goods. Reinforce it, if necesary. Then weld a suitable wire mesh to the frame. The size and design will vary from rig to rig, but all will serve the same purpose: minimizing the danger of a loose spinning chain.

Build Wireline Support Of H-Frame, Angle Iron

Make a wireline support from a plate metal pipe H-frame with angle iron front support and bolted floor plate to insure anchoring during bottom-hole measuring procedure.

The H-frame legs consist of two 2-inch tubing nipples cut to the desired height and welded to a half-inch base plate, perforated at two points for floor plate bolts. A 6 or 7-inch piece



of angle iron is welded on top of the support legs.

Two half-inch plates are welded to the top of the angle iron to eliminate any movement of the wireline unit. The top section support is drilled so that wireline unit can be bolted on.

A section of 2-inch tubing is angle welded, fitted with toe plates on each end, and drilled to fit the anchor bolts. The angle pipe support can then be bolted to the floor and the face plate of the angle iron top.

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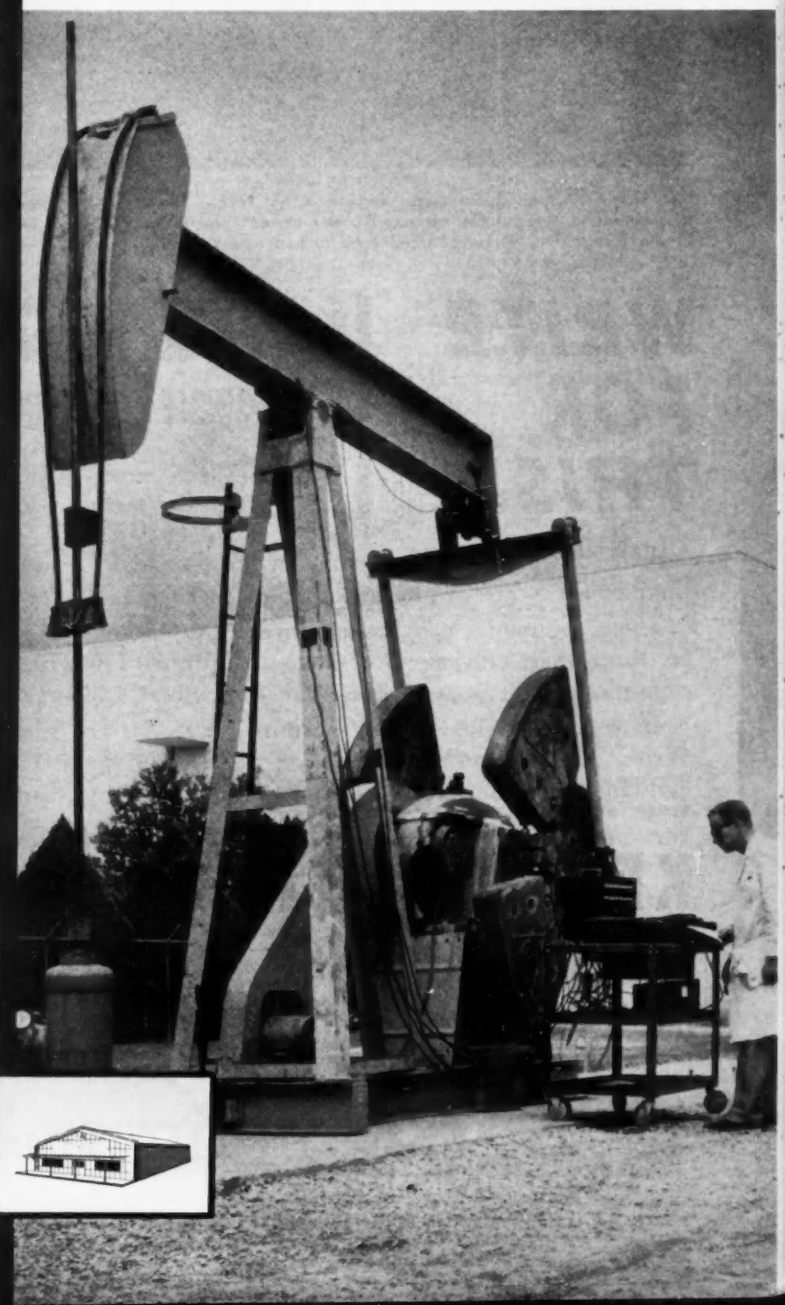

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Prevent Drain Line From Freezing with Spare Drum

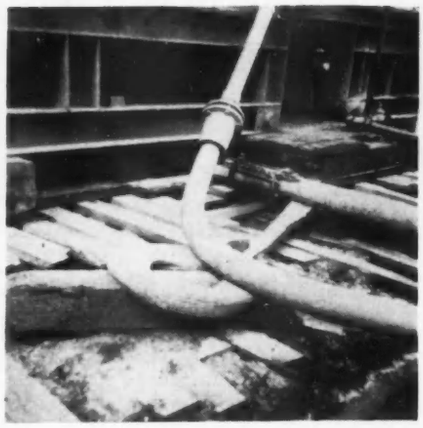
Freezing of separator or treater drains can be prevented by cutting a 55-gallon drum to fit the vessel and burying the drum so that its top projects about 18 inches above the drain line.

A cut is made completely around the drum so that the top and 2 inches of the side is removed. The diameter of the buried portion is then made smaller by bending in the sides so that the removed top becomes a lid. The drum then is filled with pulverized cork, cotton seed hulls, or other insulating material, and the lid put in place.

Discarded Tire Makes Good Mud Hose Support

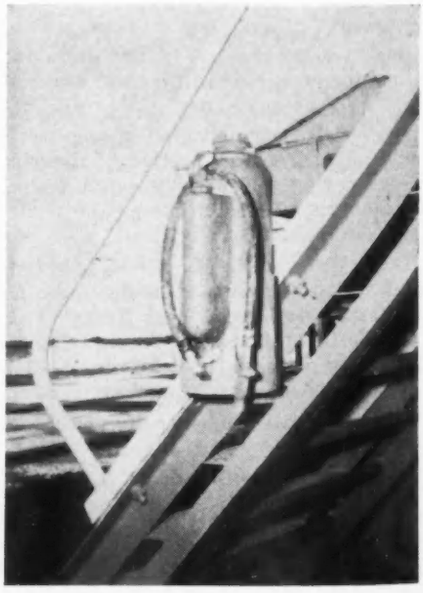
To line up pipes and hoses around a rig, it is sometimes necessary to brace or support the pipe with a timber. This Gulf Coast contractor had trouble lining up the rubber mud hose with the steel stand pipe, until he placed a timber under the rubber hose.

The vibration of the hose on the timber was causing the hose to wear. To avoid this costly wear, a discarded tire was placed between the timber and rubber hose. (See photo below).

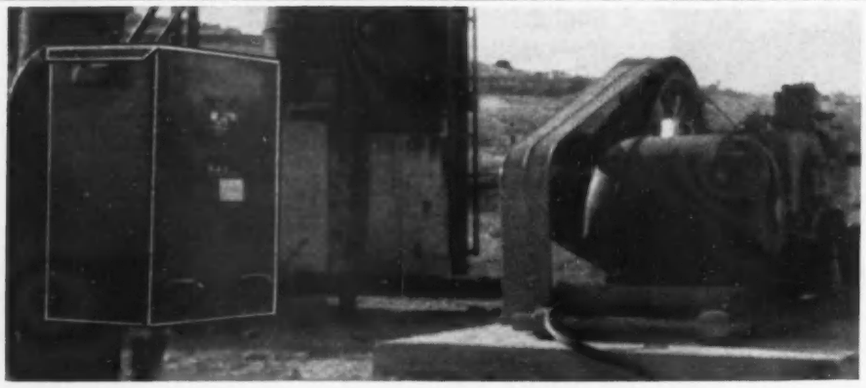


Mount Fire Extinguishers In Convenient Locations

A fire extinguisher mounted near ground level on the rig steps is easily accessible in event of fire. Many times the fire extinguisher is located too near points where a fire is likely to begin.



This simple mounting made of scrap pipe, is near the likely exit route in event of fire. The cost is nominal.



Salt water disposal plant near Sterling City, Texas. The 25 HP three-phase motor operates efficiently and dependably on single-phase current, thanks to the H-A-S Phase Conversion System in the foreground. Motor-mounted type also available.

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"How to use THREE-PHASE MOTORS on SINGLE-PHASE CURRENT! Costs less—works better."

Some of the biggest companies in the petroleum industry are now using three-phase motors with single-phase current.

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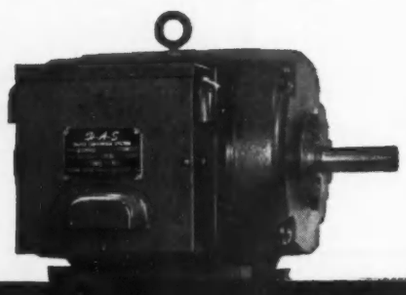


H-A-S PHASE CONVERSION SYSTEM

New formation sampler reduces operational costs

The packer is run as an integral part of the drill string and the fluid samples are recovered in a wire line retrievable reservoir

By Walter E. Hyde
Mechanical Engineer
Halliburton Oil Well Cementing Co.
Duncan, Oklahoma

THE CONTINUOUS retrievable sampler allows formation evaluations to be made while drilling without round trips. This is accomplished by incorporating a packer as part of the drilling string and recovering the formation fluids in a retrievable sample reservoir. Only a short period is required for hole conditioning prior to sampling operations. Also, a minimum amount of time elapses between drilling the section to be tested and the actual sampling. This is an advantage when formations tend to take mud or filtrate at a fast rate. Formations may be sampled at any time during the drilling operations while both the drill pipe and hole remain full of fluid.

The sample of formation fluids recovered is not a laboratory sized amount. Fluid recoveries of 25 gallons is not uncommon, and larger volumes are possible. Usually, the bottom three feet of hole are sampled, and it has been found that all the rat hole mud does not have to enter the sampler chamber first but the formation fluids channel through this mud thereby minimizing the amount of contamination. Much of the contamination is confined to the top of the sample chamber and is held there by a series of check valves. Almost pure formation fluids are contained in the bottom section of the sample chamber. A pressure recorder located in the sampler records all pressures (Figure 1).

The tool itself consists of two major assemblies:

- The packer assembly (Figure 2)
- The sampler assembly.

The packer assembly is made up as part of the drilling string and contains an inflation type packer for formation isolation and a sleeve type valve and closing spring for packer inflation.

The sampler assembly is a retrievable device which contains the sample reservoir barrels with a pressure bleed-off valve at the top, a hydraulically operated sampler valve and a BT pressure recording device.

The operation of the tool is shown in Figure 3. This diagram is schematic and shows the tool in operation for sampling. During drilling, no special precautions are required. The packer remains in the deflated condition because its inflation passages remain closed by the valve sleeve and closing spring. Because the packer is normally three feet from the bit, it is held away from the side of the hole. Drilling mud and cuttings flowing around the packer have a negligible eroding effect upon the packer.

When it is desirable to sample a formation, the sampler assembly is dropped into the drill pipe (Figure 3A) and allowed to fall freely to its landing seat. The sampler barrels, as mentioned above, may be of an optional number. The determining factor for the maximum number of barrels that may be run is the strength of the sand line used. Each barrel is seven feet long and has a 0.9 gallon volume. The barrels are under atmospheric pressure.

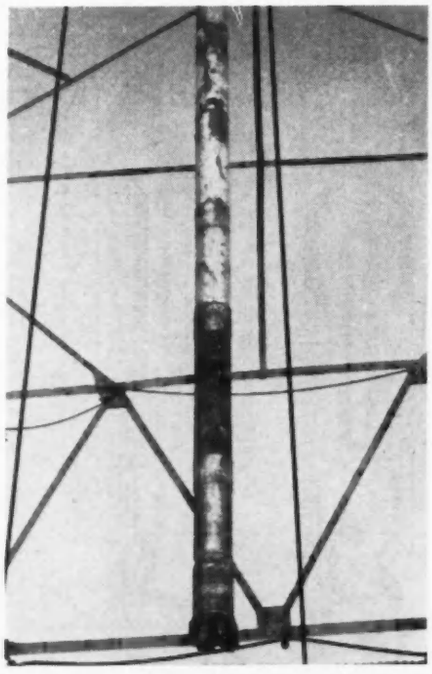


FIGURE 2—The inflation type packer and inflation valve becomes a rigid integral part of the drilling string with no telescoping joint and only one moving part.

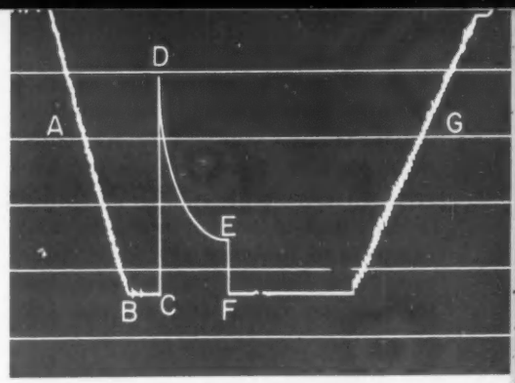


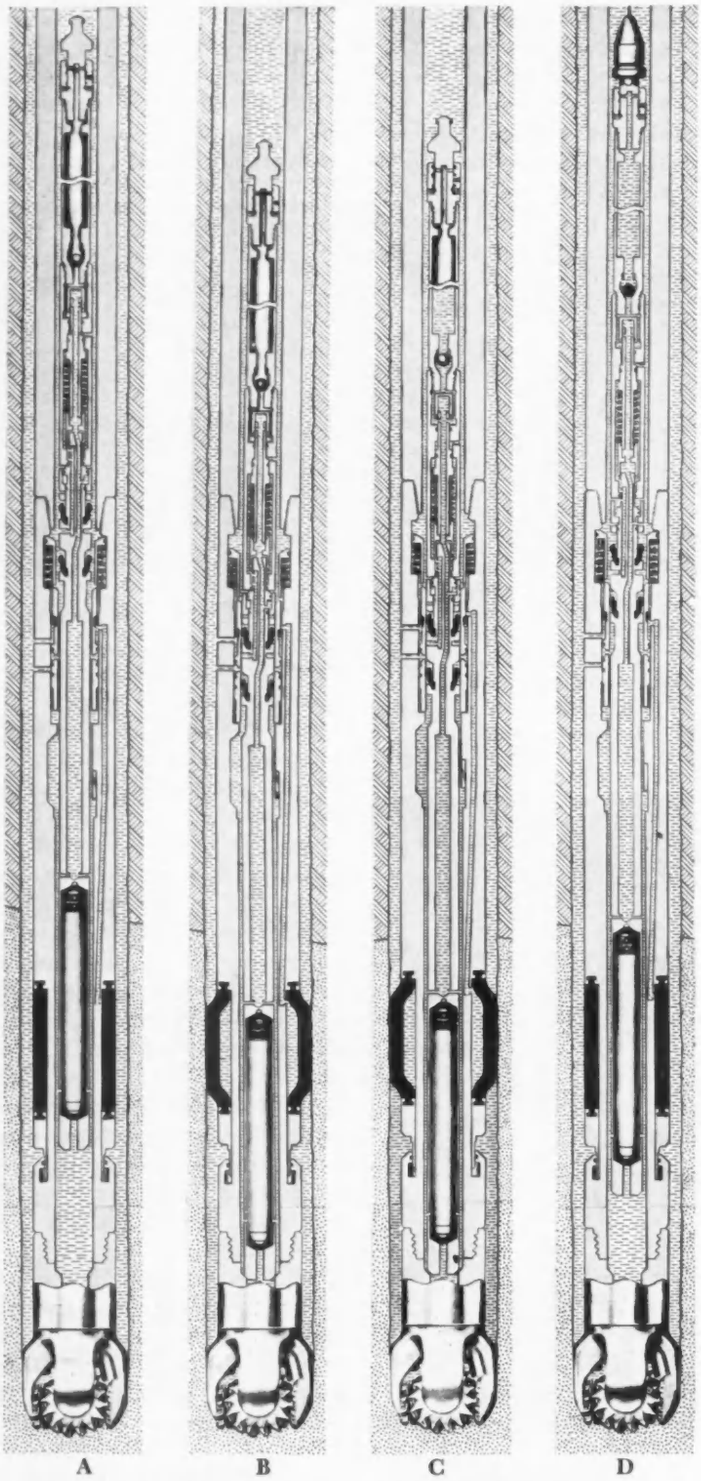
FIGURE 1—A permanent pressure recording is obtained with the continuous retrievable sampler. The typical pressure recordings are: (A) Going in the hole (B) Initial hydrostatic pressure (C) Sampler valve opened (D) Initial flow pressure (E) Sampler valve closed (F) Final hydrostatic pressure (G) Coming out of the hole.

After the sampler assembly has reached its seat, the bit is lowered to touch the bottom of the hole and pressure is applied (Figure 3B). Pressure is contained in the drill pipe by a cup seal seating in the valve sleeve. The pressure differential created across the sleeve causes the sleeve to move down and allows the inflation passage to the packer to communicate to the inside of the drill pipe. The packer then expands under internal pressure and seals against the well bore. A packer pressure of 300 pounds per square inch pressure is sufficient to seal all annulus pressures from either end.

With the packer set the pressure in the drill pipe is further raised and acts across the differential area of the sampler valve causing it to overcome the spring force holding it closed and allows the valve to open. The formation fluids may then flow into the bit, passageways, sampler valve and into the barrels (Figure 3C). The sampler valve is fully open at 600 psi, but pressures up to 1000 psi are applied as added insurance. Usually, the valve is left open for 10-20 minutes to allow the sampler barrels to fill and stabilize in pressure with the formation. At the conclusion of the flow period, the applied pressure inside the drill pipe is

removed which allows the sampler valve to close first and the packer to deflate. The sample of formation fluids then is trapped inside the barrels at reservoir pressure. Operation of the tool is accomplished by only raising and lowering the pump pressure. The inflation valve sleeve and the sampler valve stem are the only two moving parts in the tool.

The sampler assembly is retrieved with a sand line (Figure 3D) and the sampler barrel pressure is bled off at the surface by means of a bleed-off valve below the fishing neck. After the pressure is removed, the fluids may be recovered from the sampler for analysis.



A. Dropping Sampler
B. Inflating Packer
C. Sampling Formation
D. Retrieving Sampler

FIGURE 3—A schematic operational diagram for the continuous retrievable sampler.

Further sampling or drilling may be resumed.

Because, as a rule, considerable testing is required with coring, it is possible to core with wire line core tools prior to this method of sampling. It should be pointed out that coring is only a complimentary service and the tool is not dependent upon it as it may be used with any bit. In the event coring is performed, the coring tools are supplied by the customer.

Only one tool size is in use at the present time. The diameter of the packer assembly is 6¾ inches and is to be used in 7⅞ inches-8¾ inches diameter holes. It is 11 feet long when used in conventional drilling and 16 feet long when used with coring tools. This added length is to accommodate the core barrel. The sampler assembly has a maximum diameter of 2.680 inches at the steel parts and cup seal diameters of 2¾ inches and cannot be used in pipe or drill collars with internal diameters less than 2 13/16 inches.

The continuous retrievable sampler has been in operation in Southwest Texas for 10 months. Most of the tests have been conducted in 7⅞ inch holes. Pressure differentials of 5,000 pounds per square inch have been encountered. Satisfactory results have been obtained with the tool.

New developments contemplated include a smaller sampler assembly for 3½ inch drill pipe and other accessories.

About the Author

Walter E. Hyde is a mechanical engineer with Halliburton Oil Well Cementing Company. A graduate of Oklahoma State University, he has been associated with Halliburton since October 1950. He was first employed as a field engineer for special formation testing services and since early 1953 has been with the Tool Development section at Duncan, Okla. Hyde has done extensive work on formation testing tools which includes the hydrospring tester, hydraulic jars, inflation packers and mechanical perforating equipment.

In Oklahoma, Kansas . . .

Sonic log proves valuable porosity tool

Freedom from statistical variations, independence of mud type and hole size, excellent application as a correlation and geophysical tool are additional features of the technique

By H. E. Pickhardt, Engineer
Schlumberger Well Surveying Corporation, Duncan, Okla.

and L. M. Holley, Engineer
Schlumberger Well Surveying Corporation, Wichita, Kan.

THE SONIC LOG has become an established method of well logging in the Oklahoma and Kansas areas. A continuous recording of the time required for sound to travel through a 1-foot thickness of formation, the technique provides excellent porosity data and has additional application as a correlation and geophysical tool. The log also is applicable under a broad range of borehole and formation conditions; it can be run in holes varying from 5 to 12 inches in diameter and functions equally well in holes filled with mud, water or oil. It cannot, however, be recorded in empty holes.

In the various provinces within the Mid-Continent, velocities measured in formations in one locale may be ascribed to that formation over a large area provided composition is similar. This has made possible standardization of interpretation and log presentation.

Description. The sonic logging device was developed originally by Humble Oil & Refining Company.[1] Additional research and development has resulted in the tool discussed in this article.

The logging instrument measures the interval travel time (on a per foot basis) between arrivals of a sonic wave at two receivers spaced a short distance apart (Figure 1). This time is measured in millionths of a second. Since travel time measurements are on a per foot basis, regardless of the span between receivers, logs are scaled in microseconds per foot. The velocity of sound propagation in a formation can be computed by dividing one million by the interval travel time recorded for that formation. Hard formations will transmit sound faster than soft formations. (Shales may have a velocity as low as 6,000 fps while dolomite velocity may be as great as 25,000 fps.)

Down-hole equipment consists of an electronic cartridge and a sonde, both 3⅝ inches in diameter and approximately 10 feet long. The sonde contains the transmitter and three receivers and is constructed of a low velocity, non-rigid material. Centralizers may be used to center the device and maintain the tool parallel to the wall of the hole. The tool records to within 3½ feet of bottom.

Either a 1-foot or a 3-foot receiver span may be used and since only that thickness of formation equal to the receiver span is measured, the tool is perfectly focused. The 1-foot span

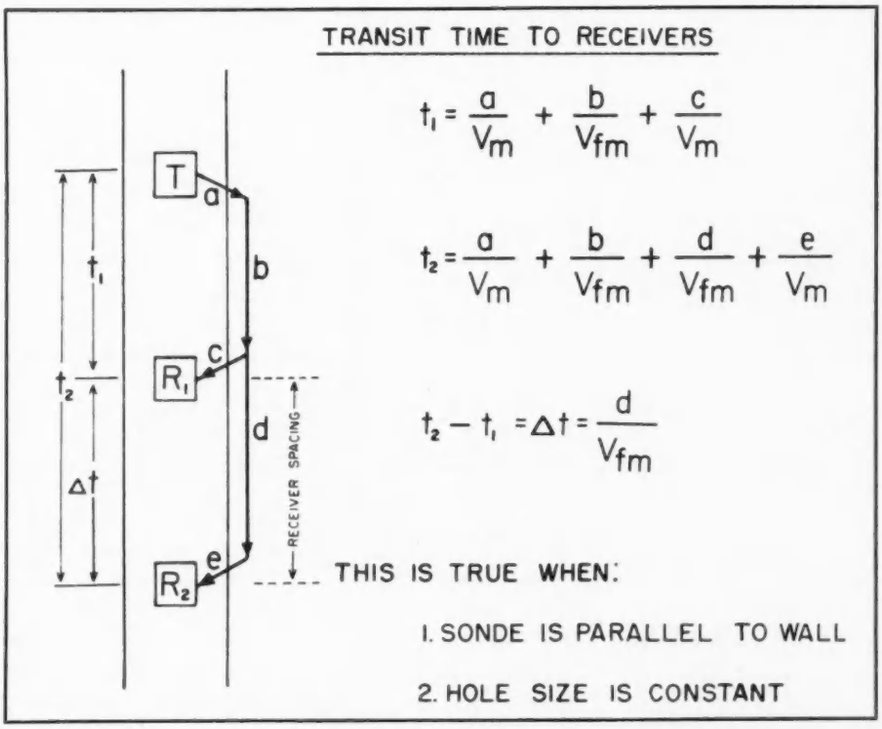
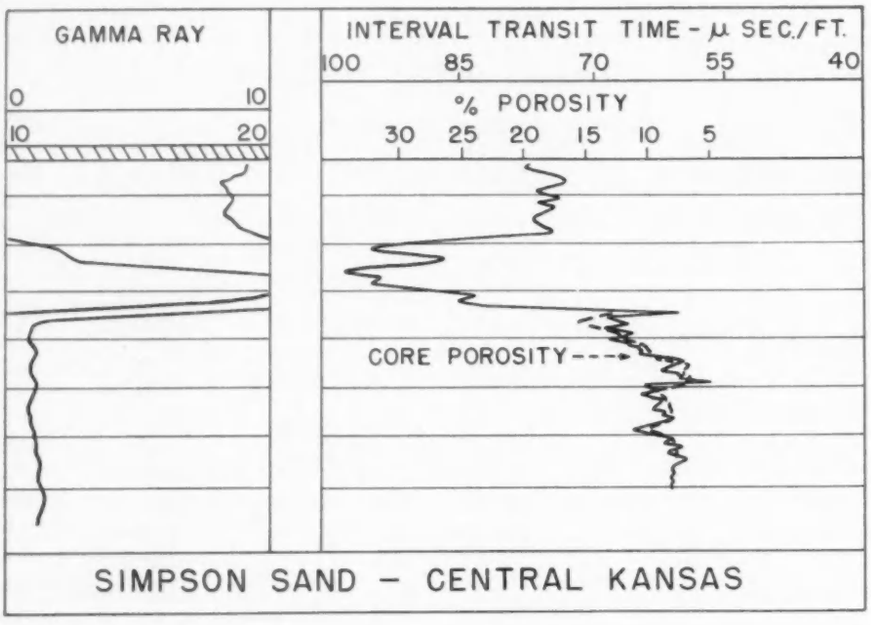
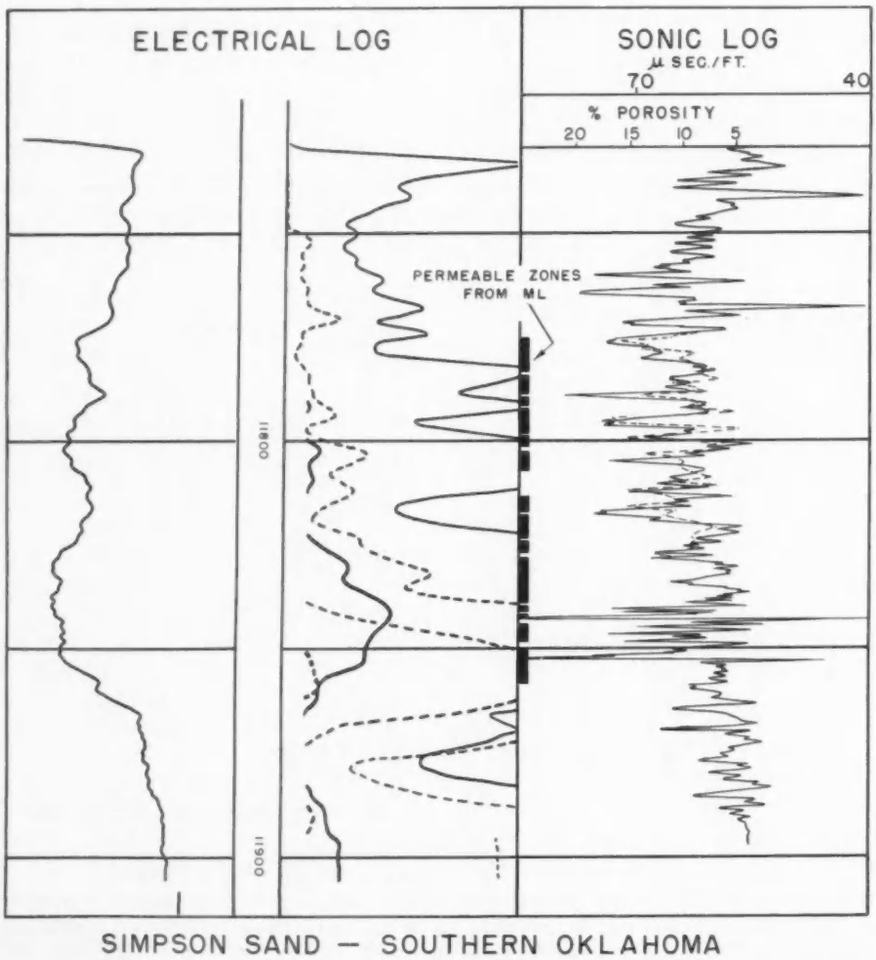


FIGURE 1—Basic features of the sonic log are a two-receiver system and a short-receiver span. When a receiving system such as this is used, the effect of hole size and mud type is eliminated; the effect of caved zones also is eliminated except at the lower and upper boundary of the cave. At the lower boundary, the log will show a thin, sharp deflection to the right. At the upper boundary, the effect is in the opposite direction and of the same magnitude. These effects cancel each other when the travel time is integrated.[2]

gives a curve which correlates well with foot-by-foot core analysis. The 3-foot span averages the travel times over a 3-foot interval, giving an average porosity over a section of formation more nearly coinciding with that investigated by the induction-electrical log. This makes the induction-electrical log and 3-foot span sonic log an excellent combination for porosity and water saturation determination in fresh muds.





FIGURES 2 and 3—Matrix velocities are relatively constant for formations of like composition and geologic age. For both of these examples, a V_m of 19,500 fps was used in determining porosity. Note the agreement between log porosity and core porosity, which has been plotted as the dotted curve in each figure.

The vertical investigation of focused resistivity logs is very nearly that of the 1-foot receiver span. Therefore, in highly resistive beds and salt muds, where focused resistivity logs are necessary for determination of formation resistivities, it is recommended that the 1-foot span be employed.

In order to record the sonic log the borehole must be full of liquid. The fluid furnishes a sonic bond between the sonde and the wall of the hole. The presence of gas cut or aerated drilling muds tends to lessen effect of this sonic bond and it may be difficult to obtain a usable log under these conditions. The device works equally well, however, in water or oil base muds.

Accurate calibration. Effective use of the sonic log as a porosity or geophysical tool demands a high degree of accuracy. It is possible to read interval transit time from the log to within one millionth of a second. To insure that the measurement made in the hole is at least equal to the accuracy of reading the log, the calibration technique is based upon very close-tolerance calibrating crystals. An internal crystal permits a down-hole check of the calibration.

The log is scaled to provide good resolution of porosity values throughout the range of formation velocities that might be encountered. Since the highest velocity that might be encountered is 25,000 fps, it is customary to shift the zero travel time point so that the edge of the log corresponds to this value. The travel time corresponding to 25,000 fps is 40 microseconds per foot. The sensitivity of the log normally is adjusted such that each scale division on the log corresponds to three microseconds per foot. A two-track log would thus indicate a standard scale of 100—70—40 microseconds per foot. This standard scale appears at the top of the log shown in Figure 2.

Porosity determination. Some factors which affect formation velocity are density, elasticity and overburden pressure on the matrix. Since fluid velocity differs from matrix velocity, the amount and type of fluid in the formation, and the pressure on the fluid are important. The amount of fluid present depends on formation

FIGURE 4—These logs (right) were recorded through a section of Mississippian chert which yielded core porosities from 11 to 35 percent (plotted as the dotted curve on the sonic log). A V_m of 18,000 fps was used in deriving the porosity scale. Again, note the close agreement between log and core porosity data.

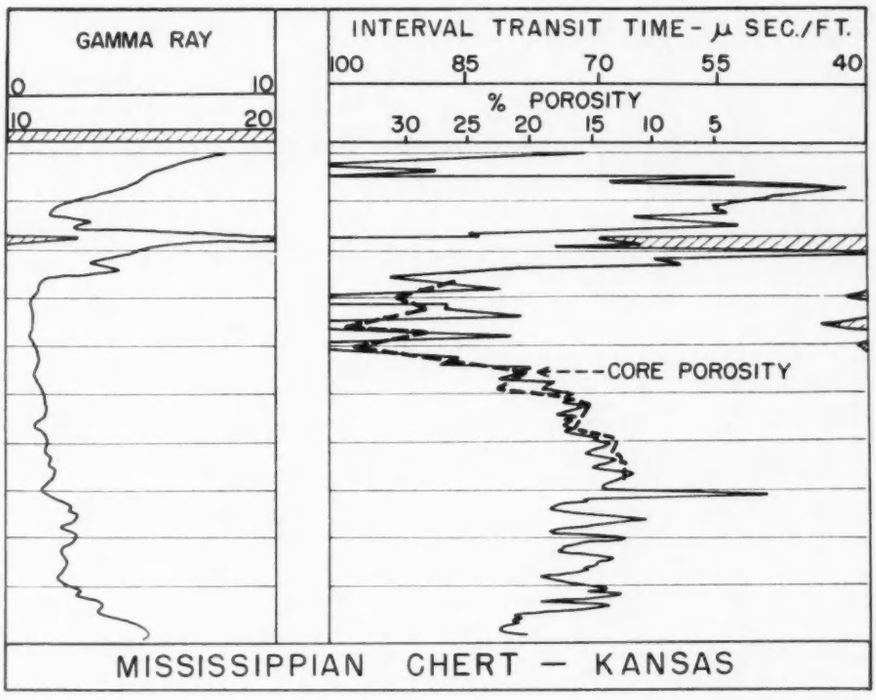
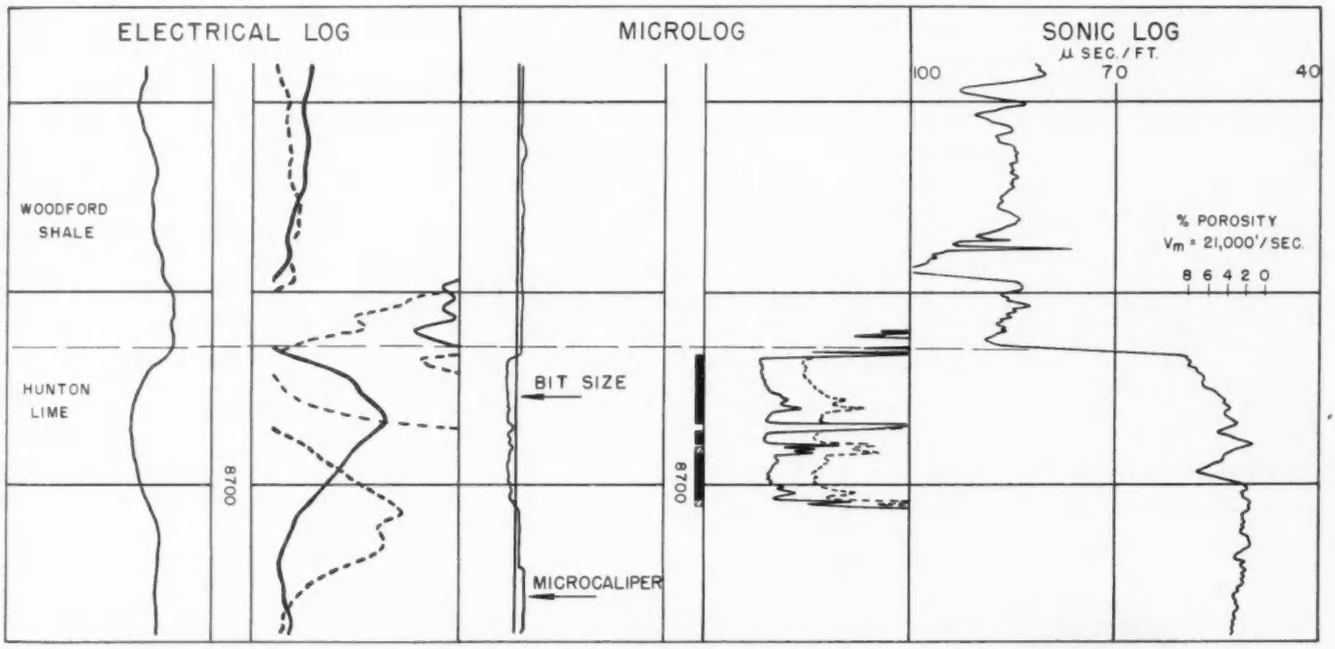


FIGURE 5—Here is a composite log (below) recorded through the Bois D'Arc section of the Hunton limestone in McCalin County, Oklahoma. Permeable zones are readily recognized from the microlog but porosity determination is indeterminate due to the low range of porosity. From the microlog it can only be said that the porosity is probably less than 10 percent. Notice that the sonic log through the permeable zones (as delineated by the microlog) indicates porosity ranges between 2 percent and 8 percent, with an average of about 5 percent. With pay thickness indicated by the microlog and porosity determined by the sonic log, a more accurate estimate of reserves can be made.



porosity. When the pore space is filled with hydrocarbons the sonic log will indicate porosities which are optimistic. It is important to note that this is the only porosity tool with this characteristic. If affected by unflushed hydrocarbons, all other porosity tools tend to be pessimistic until a correction is made for residual hydrocarbons. The ability of this log to give optimistic porosities in zones containing oil or gas is advantageous since it will encourage further investigation of the zone before the well is abandoned.

Porosity determination from the sonic log is based on a time average relationship proposed by M. R. J. Wyllie, A. R. Gregory, and L. W. Gardner.[3] It simply states that for clean and compacted formations porosity may be determined from the following expression:

$$\frac{1}{V} = \frac{\phi}{V_f} + \frac{1-\phi}{V_m}$$

where

V = Average formation velocity, fps.
V_f = Velocity in the interstitial fluid, fps.
V_m = Velocity in the rock matrix itself, fps.
ϕ = Fractional porosity.

By use of the formula relating to porosity, charts may be constructed where Δt is plotted versus porosity for a given value of matrix velocity. (See World Oil, April, 1959, Page 114.)

Matrix velocities are fairly constant for formations of similar composition and geological age. (Uniformity of matrix velocity for a given formation is illustrated by Figures 2 and 3.) Therefore, it is possible to assign a matrix velocity (V_m) of 18,000-19,500 fps for most sandstones in the Mid-Continent area. Most carbonates will have a matrix velocity between 21,000 and 23,000 fps and dolomite generally will vary from 23,000 to 25,000

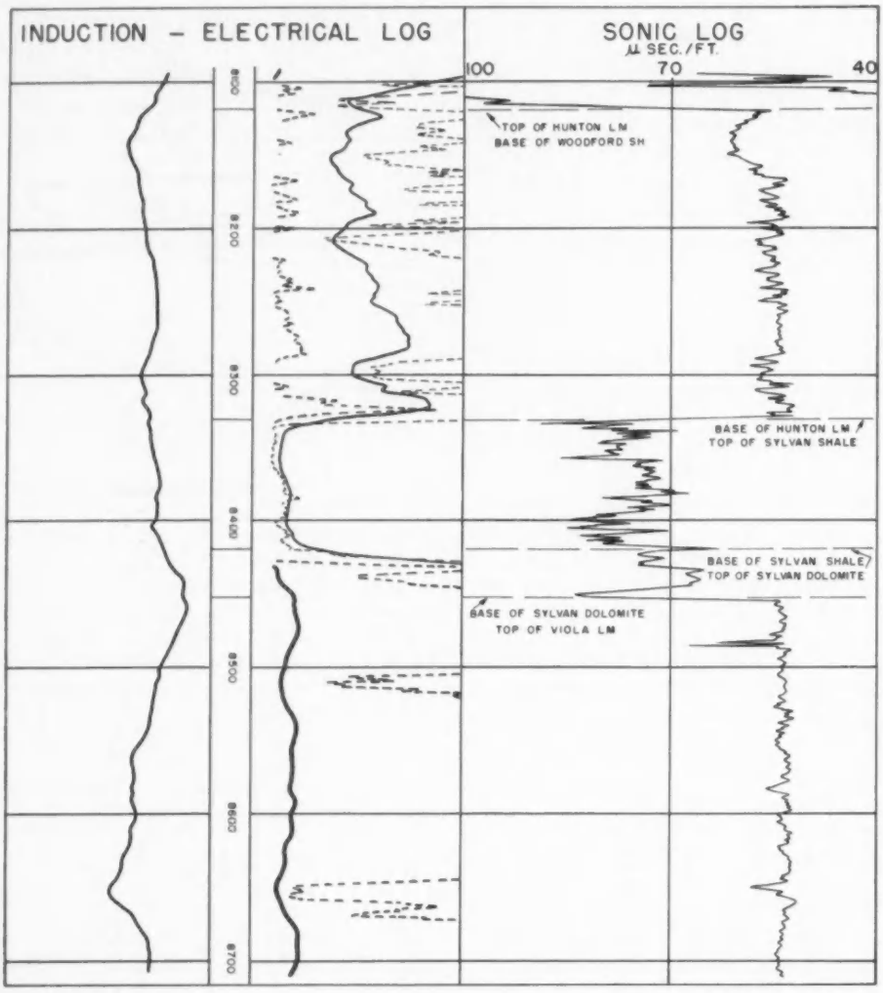


FIGURE 6—The utility of the sonic log for correlation purposes and picking tops is illustrated by this composite log run in the Golden Trend Area. Notice the sharp change in interval travel time at the Woodford-Hunton contact at 8,118 feet. Woodford shale on basic resistivity logs appears highly resistive and is difficult to delineate from limestone. With the sonic log, the shale has a characteristically high travel time of approximately 100 microseconds per foot, or greater, and is strikingly evident on the log. The top of the Viola limestone is shown by the sonic log, at 8,453 feet. This contact is difficult to pick from resistivity logs since the Sylvan dolomite section, from 8,420 feet to 8,453 feet, also is highly resistive.

About the Authors

H. E. Pickhardt obtained a B.S. degree in electrical engineering from Oklahoma State University in 1950. He joined Petty Geophysical Company upon graduation and joined Schlumberger Well Surveying Corporation in 1951. He has worked throughout the Oklahoma area and is presently a field engineer in Special Services, stationed in Duncan, Okla.

L. M. Holley attended the University of Wisconsin, Oklahoma A&M College and Tulsa University. He received a B.S. degree in geophysical engineering from Tulsa in 1952, and was employed by Schlumberger at that time. He has worked in various locations in Kansas and was assigned the job of introducing the first sonic logging equipment into the Mid-Continent area in 1958.

fps. The matrix velocity for chert is approximately 18,000 fps.; this value gives excellent results for the tripolitic chert often found in the Mississippian. In other cherts, V_m may go as high as 19,500 fps. It is expected that local variations in these matrix velocities will be found but there is no justification for indiscriminately shifting the matrix velocity to match any one well. For example, if, an 18,000 fps matrix velocity is assumed when V_m actually is 19,000 fps, the numerical error in porosity determined is only 1.25 per cent.

Figures 4 and 5 are additional examples which illustrate the utility of the sonic log as a means of determining porosity.

Correlation. Correlations with the sonic log frequently solve problems that are difficult to resolve by other logging methods. In such cases the less detailed three-foot receiver span normally is employed. Figure 6 illustrates the superiority of the sonic log, under certain conditions, for correlation and picking tops. This example is of an induction-electrical—sonic log through the Woodford-Hunton-Sylvan-Viola series of the Golden Trend Area.

Geophysical application. It is possible to integrate the log and determine the total travel time for any portion of the hole. In this respect the sonic log has valuable geophysical applications. The total travel time may be obtained by two methods. The area under the curve can be planimetered or a special integrator panel may be employed at the time of logging. In the latter case, this integrated time is recorded on the log as "pips" each thousandth of a second as shown in Figure 7 (Page 120).

The integrated log gives the geophysicist velocity data which may be used in the area adjacent to the well. These data are particularly advantageous in areas of variable velocity gradients.

Conclusions. The sonic log has become firmly established as a logging tool in the Mid-Continent area. Outstanding features of the technique are:

- Porosity is determined effectively.

Continued on Page 120

Part 1

How to combat lost circulation while cementing

High density and viscous cement tend to break down the formation through the cementing interval

By A. J. Willis
District Superintendent, Phillips Petroleum Co., Great Bend, Kan.

R. A. Wynne
Division Superintendent, Drilling Specialties Co., Tulsa

ANY TIME FLUID is circulated in an uncased hole, an operator may be plagued with lost circulation. When this fluid is cement, loss of circulation is magnified many times. Normally, this is because of the density of the cement and the viscous nature of the cement due to the high solids ratio.

Although the individual problem caused by loss of circulation while cementing may be almost as numerous as the number of wells drilled, there are three major problems encountered.

1. Communication between zones which had not properly sealed off with cement. This can lead to a number of secondary problems such as contamination of fresh water supplies or loss of production.

2. Corrosion of exposed pipe. Many times water is corrosive in areas where lost circulation is prevalent. Where the pipe has not been properly protected with cement, casing failures caused by corrosion become complex.

3. Production from an upper zone becomes difficult because of improper covering of cement.

When an operator gets ready to cement a casing in place, he has some knowledge of whether the formation will support the cement-slurry column or whether he will encounter loss of circulation through a specific interval. As a result of this knowledge, necessary precautionary measures will be taken to prevent loss of circulation while cementing.

At the time of cementing, the most prevalent type of lost circulation is to a weak formation, which is one where a small over-balance

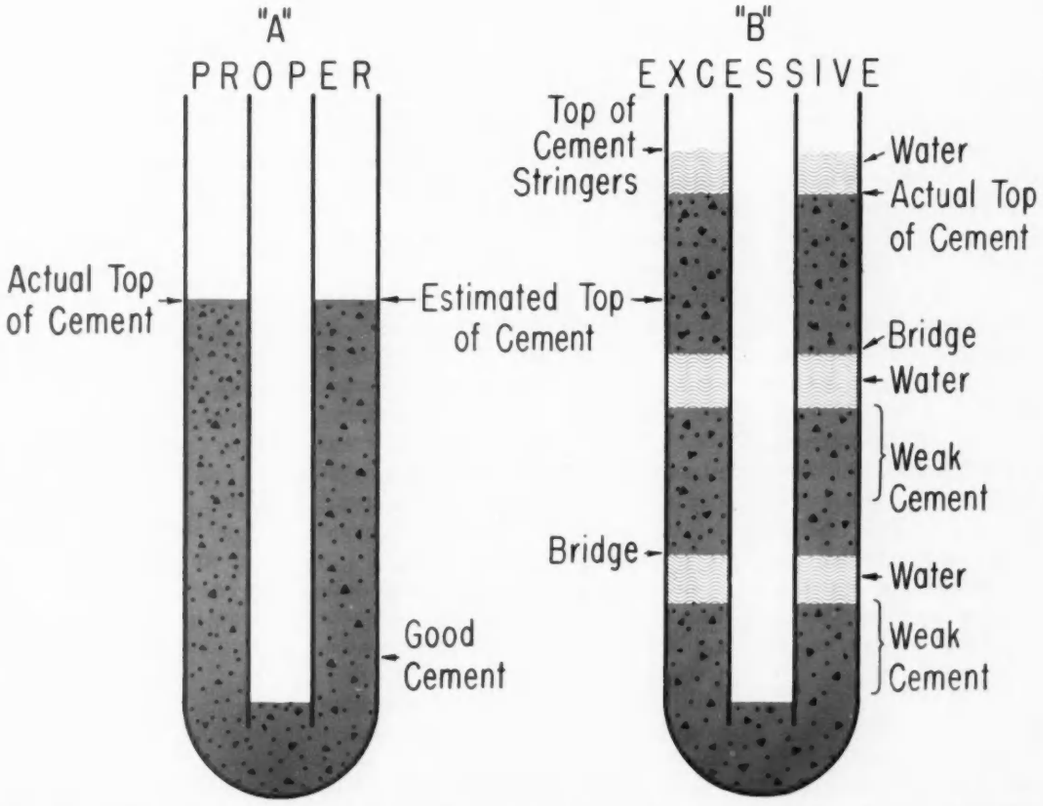
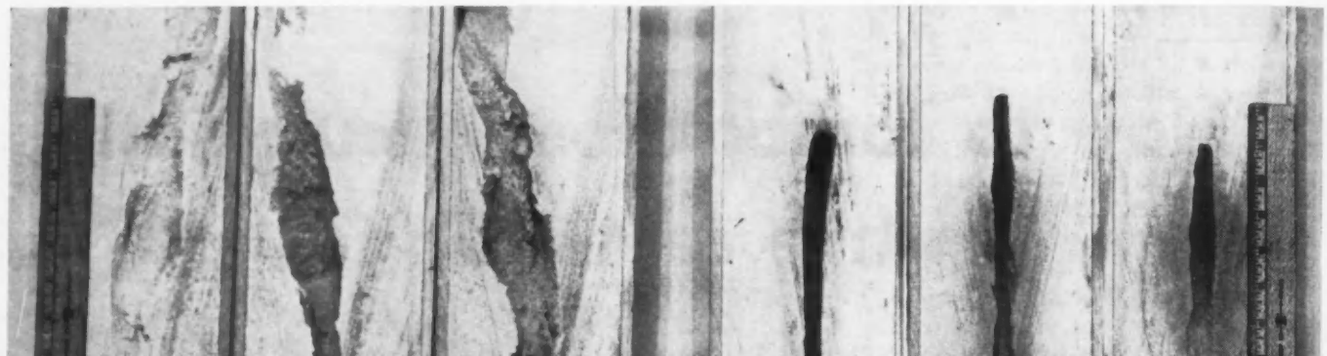


FIGURE 1—The water-to-cement ratio is important in obtaining efficient cementing operation. Excessive water most likely will result in water pockets throughout the cement column.



A
Portland cement with 40 percent diatomaceous earth. Water—22.8 gal/sk. Curing time—24 hours. Temperature—140 degrees F.

B
Portland cement with 40 percent diatomaceous earth. Water—22.8 gal/sk. Curing time—48 hours. Temperature—140 degrees F.

C
Portland cement with 40 percent diatomaceous earth. Water—22.8 gal/sk. Curing time—72 hours. Temperature—140 degrees F.

D
Portland cement with 20 percent diatomaceous earth. Water—15.5 gal/sk. Curing time—24 hours. Temperature—140 degrees F.

E
Portland cement with 20 percent diatomaceous earth. Water—15.5 gal/sk. Curing time—48 hours. Temperature—140 degrees F.

F
Portland cement with 20 percent diatomaceous earth. Water—15.5 gal/sk. Curing time—72 hours. Temperature—140 degrees F.

FIGURE 2—Results of perforation tests at varying curing times of portland cement with 20 and 40 percent diatomaceous earth.

of formation pressure is sufficient to cause the formation to part and take fluid. These weak formations may be natural or may have been caused by the plugging of a fractured zone with lost circulation material while drilling. Fractured zones frequently occur in weak formations.

A thief zone normally can be recognized because the water-loss-control material many times will stop the loss of circulation while drilling. Loss of circulation while drilling through a fractured zone normally can be corrected with the use of bridging materials in conjunction with low-fluid-loss drilling fluids. Loss of circulation in cavernous zones can be corrected only with cementitious materials while loss of circulation to a weak formation normally may be corrected by adjusting mud density. Combinations of these various types of lost circulation sometime make the solution to the problem difficult. Normally, then, it is good practice in lost-circulation country to run a mud with a bridging material which has as low a fluid loss as economics allow.

Lightweight cement. There are two general methods used to combat lost circulation while cementing. These two methods may be used either individually or together. If mud or cement is lost primarily because an over-balance of formation pressure is sufficiently large to fracture the formation, a low-density cement is used. On the other hand, if the formation contains existing fractures, various bridging materials are incorporated into the cement slurry.

Many times, the density of cement slurry is decreased by increasing the water-to-cement ratio. Actually, there is a very narrow range of densities to which neat cements should be slurried. For most neat cements, this density range is in the order of 1.5 ppg with a minimum density of 15.4 ppg for API Class A cements, and approximately 16 ppg for API Class D, E and F cements.[1] The proper density range, and thus the amount of mixing water, might vary with different brands of cement. The amount of mixing water required will depend largely upon the fineness of grind of the cement used.[3]

One major cause of cement failures is excessive water-to-cement ratio. The effect of improper water-to-cement ratio is shown in Figure 1. Diagram A shows a casing cemented with cement having a proper water-to-cement ratio. Diagram B shows the effects of cement having excessive water-to-cement ratio. Assume in both cases A and B that a 5½-inch casing is cemented in an 8¾-inch hole. In both cases, 1,100 sacks of cement were ordered out for the job.

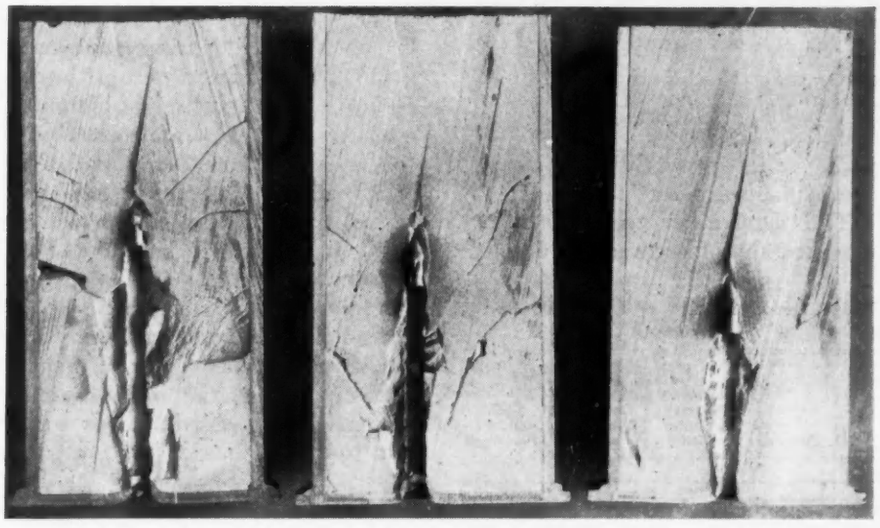
In Diagram A, the cement was mixed to 15.8 ppg, and in Diagram B the cement was mixed to 15 ppg. Assuming the hole was to gage and no loss of circulation, the fillup would be 5,000 feet in Diagram A and 5,582 feet in Diagram B. If, however, the same fillup factors were used in both cases, the top of the cement in Diagram B would be 582 feet higher than expected. If a temperature survey was run, the top of the cement in Example B would be higher than predicted. Channeling probably would be considered as the explanation for the high top of cement. Channeling could have also been suspected if hole was subsequently perforated below the top of the cement and water was produced, or if at a later date the casing corroded below the top of the cement. Actually, however, no channel job whatsoever may have been experienced because cement when mixed with an excessive water-to-cement ratio will bridge and form water pockets throughout the cement column. Immediately below these water pockets is generally an area of weak cement. These bridges, water pockets, and weak-cement areas give

indications that many times are interpreted as channeling. However, this is not to say that channeling does not occur. Rather, it is maintained that in many cases of so-called channeling excessive water-to-cement ratio may have been the cause.

Because the density changes with a change of water-to-cement ratio for neat cement are limited, additional means for decreasing the density of oil well cements were sought. One of the first things *that comes to mind* is the use of an entirely different type of *cementitious* system. A number of such systems have been advanced and, although theoretically sound, have been economically unsuccessful. However, such a system still presents a real possibility. The more general approach to low-density cement is to modify neat portland cement slurries. This may be done by diluting the cement solids with solids of lesser density or by adding a solid diluent which permits greater proportions of water to be added without separation of solids. Of course, part of the water may be substituted with a liquid of lower density. Probably the best approaches to this problem are combinations of these techniques.

One of the first materials to be used to decrease the density of cements was bentonite, which still is widely used. Bentonite is used in cement primarily because it absorbs great amounts of water.[3, 4, 5, and 6] When bentonite first was used in cement, high strengths were considered primary requirements for cement. Because bentonite, as all other light-weight additives, decreases the strength of cement, early concentrations were held to about 2 or 3 percent. These small percentages of bentonite did more for the workability of cement than they did to reduce density. As a more scientific approach to the uses of cements in oil wells was developed, strength figures were revised downward. This allowed the use of greater and greater percentages of bentonite which resulted in greater reductions in the slurry density with, of course, a corresponding reduction of strength as shown in Table 1.

The lower strengths obtained with bentonite cement enabled perforation with less bullet resistance and less shearing. Actually, it probably is not compressive strength but resiliency which dictates the ease with which a cement can be perforated. Normally, all low-strength cements are resilient.



140° F. Neat 3 Days 140° F. Neat 7 days 140° F. Neat 14 days

FIGURE 3—Here are perforation results in neat cement at a constant curing temperature of 140 degrees F. and a varying curing time of 3 to 14 days.

The use of high percentages of gel has serious disadvantages. As the amount of bentonite in the cement is increased, the susceptibility of the cement to attack by corrosive water is greatly increased. Attempts have been made to correct this situation by including pozzolanic material in the gel cement.[7, 8] Although the use of pozzolans has increased the resistance of gel cements, they still are susceptible to this attack. Whereas the use of bentonite is primarily the approach of adding a solid diluent which permits greater proportions of water, the addition of pozzolans is primarily the addition of a solid diluent having density less than that of portland cement. The combination of these two materials further decreases the set strength of the cement (Table 2).

Chronologically, sandwiched between the development of gel cements and gel-pozzolan cements was the development of cements containing expanded perlites. Expanded perlite, because of its cellular, bubble-like structure, tends to float on neat-cement slurries. These tiny glass bubbles have a density of about 15 pounds per cubic foot. By replacing part of the cement with this light-weight diluent, low-density cements are possible.

The addition of 2 to 6 percent bentonite to the cement greatly reduces the tendency for expanded perlite to float and produces a slurry in which the perlite remains in much better dispersion throughout the cementing job. Slurry densities obtainable with expanded perlite under surface conditions are misleading; however, the tiny glass bubbles will break down under pressure, allowing fluid to saturate the interior of the particle. The slurry weight of the cement containing this material increases as it is pumped into the well. Slurry weights at the surface and at 3,000 psi are included in Table 3. Because of the inher-

TABLE 1—Properties of Bentonite Cement

Gel, Percent	Density, Lb. Per Gal.	Yield, Cu. Ft. Per Sack	Compressive Strength,** PSI
0	15.4	1.22	4,060
2	14.7	1.36	2,960
4	14.1	1.53	1,830
8	13.3	1.82	1,170
12	12.6	2.19	620
16	12.0	2.60	270

* From Saunders and Nussbaumer.[6] API Class A Cement.
** 24-hour compressive strength when cured at 140° F.

TABLE 2—Properties of a 50-50 Fly Ash Cement Containing Bentonite

Gel, Percent	Density, Lb. Per Gal.	Yield,** Cu. Ft. Per Sack	Compressive Strength,*** PSI
2	14.15	1.26	1,125
4	13.6	1.43	605
6	13.3	1.53	540
8	13.1	1.64	420

* 13.
** Yield in cubic feet per sack of 50-50 mix.
*** 24-hour compressive strength when cured at 140° F.

ent disadvantages of expanded-perlite cements, a blend of expanded and unexpanded perlite was introduced for use in cements.[9] This material, designated as improved perlite, offers very little advantage over expanded perlite (Table 4).

The lightweight cement systems discussed thus far cover the density

TABLE 3—Properties of Expanded Perlite Cement

Gel. Percent	Surface Density, Lb. Per Gal.	3,000 PSI	
		Density, Lb. Per Gal.	Yield, Cu. Ft. Per Sack
1 Sack Cement-½ Cu Ft Expanded Perlite			
2	13.0	13.8	1.68
4	12.7	13.4	1.84
8	12.3	12.9	2.14
1 Sack Cement-1 Cu Ft Expanded Perlite			
2	11.9	13.2	1.99
4	11.7	12.9	2.16
8	11.5	12.5	2.45

TABLE 4—Properties of Improved Perlite Cement

Gel, Percent	Surface Density, Lb. Per Gal.	3,000 PSI	
		Density, Lb. Per Gal.	Yield, Cu. Ft. Per Sack
1 Sack Cement-½ Cu. Ft. "Improved" Perlite			
2	13.0	13.7	1.91
4	12.7	13.4	2.09
8	12.3	12.9	2.38
1 Sack Cement-1 Cu. Ft. "Improved" Perlite			
2	12.1	13.2	2.46
4	12.0	12.9	2.64
8	11.7	12.6	2.93

range down to about 12.5 ppg. A different material was necessary to extend this density range to lower values. For this purpose, large percentages of diatomaceous earth have been successful. Cements containing as much as 60 percent diatomaceous earth by weight of the cement have been slurried to 10.2 ppg for successful cementing jobs in the field. Diatomaceous earth is a naturally occurring silicon dioxide containing very little aluminum. For this reason, cements containing diatomaceous earth are less susceptible to deterioration by sulfate-containing waters than cements containing bentonite or pozzolans.

Diatomaceous earth lowers cement density primarily because large amounts of water may be added to the slurry without separation of solid particles. This, of course, is assisted by the slight density advantage gained by replacing a part of the cement with the light-weight diatomaceous earth. Because a cement slurry containing diatomaceous earth is composed of non-compressible materials, the density does not change with an increase in pressure. This means that slurry densities at the surface are comparable with those down-hole. Aside from permitting the lower densities under all conditions of pressure, diatomaceous earth renders cement slurries more resistant to contamination by corrosive water. This is because of the low amount of aluminum in diatomaceous earth. If diatomaceous earth or any other additive is to be used in areas having corrosive waters, it is suggested that a sulfate-resistant type of cement be used.

Diatomaceous earth cements give excellent perforation characteristics. In Figures 2 and 3, the perforation characteristics of 20 and 40 percent diatomaceous earth cements are compared with those of neat cements cured at 140 F. The diatomaceous earth cement perforation tests were made on specimens 18 inches long, whereas the neat-cement tests were made on specimens only 14 inches long. Table 6 furnishes a comparison of the actual depths of penetrations in these three systems. Aside from the greater penetration, the diatomaceous earth cements also allow for less shattering. In fact, there is no evidence of any shattering around any of the diatomaceous earth cement perforations (Figure 2).

The most recent type of diluent to be considered in the low-density cement systems is gilsonite. Gilsonite cements normally are considered too expensive to be used merely as lightweight cements. For instance, an 11 ppg slurry of gilsonite cement is more than three times as expensive as an 11 ppg slurry of cement containing diatomaceous earth. Gilsonite is more commonly used as a bridging material, which will be discussed later. The low density obtainable with a gilsonite cement is possible through the approach of adding a diluent having density less than that of portland cement.

To get a smooth cement slurry, gilsonite must be run with bentonite, pozzolan, or diatomaceous earth.

Cement strength. Low-density portland cement admixes are accomplished only by diluting the portland cement in one of a number of different ways. Any manner in which the portland cement is diluted tends to decrease the strength of the cement as the density is decreased. The manner in which a particular density is reached, however, may dictate the strength of that particular density. Table 7 gives a 24-hour compressive strength of a number of different low-density cement formulations when cured at atmospheric pressure and 140° F. In each case, the densities listed are those taken from the literature as the density measured at 3,000 psi.

The formulations presented were chosen because it is possible to get a common density using these systems. Direct comparison of the compressive strengths of these cements can be made at a density of 12.6 ppg. Listed in order of decreasing compressive strengths, these systems are diatomaceous earth cement, gilsonite-gel cement, gilsonite-pozzolan cement, gel cement, expanded perlite-gel cement, expanded perlite-pozzolan cement. These values range from a high of 940 psi for diatomaceous earth cement to 210 psi for the expanded perlite-pozzolan cement.

These low strengths bring up the question of the strength requirement of oil well cement. Like any other part of the equipment or practice used in drilling or completing a well, the cement should be engineered for the job at hand. Of course, this does not answer the primary question regarding the strength for a particular job. One way to evaluate this problem is to check the strengths of some cements which have been used. An oil well cement containing 1 cubic foot of improved perlite to one sack of 50-50 fly-ash cement with 4 percent bentonite having a density of 12.6 ppg has a 24-hour compressive strength of 210 psi when cured at 140° F. (Table 7).

If this cement is mistakenly run at a lower density or if it is run in a well of lesser temperature, much lower strength values will result. Yet, this cement blend has been run successfully under these conditions. All other cements in Table 7, except

Continued on Page 120

For Your PRODUCTION File

Here's how to improve your gas lift installations

PART 2: Simplified method for constructing gas pressure at depth curves

By H. W. Winkler, Engineer
Camco, Incorporated, Houston

A SURFACE CLOSING pressure analysis is used to determine the operating valve in many intermittent gas lift installations equipped with casing pressure operated valves. The first part of the analysis is the calculation of the closing pressures of the valves at operating temperature and depth. The second part is the determination of the surface closing pressures from the closing pressures at depth. The operating gas lift valve is determined by comparing the calculated surface closing pressures with the actual injection gas pressure obtained from a pressure recorder or gage connected into the casing. When numerous calculations must be made, gas pressure at depth curves for the actual injection gas gravity and average temperature will reduce considerably the time required to obtain surface closing pressures from closing pressures at depth.

A family of gas pressure at depth curves for given data can be calculated rapidly if the increase in pressure due to the column of gas is considered to be a straight line. Since most pressure gages in the field are not accurate to the psi, and the average temperatures of the gas column must be estimated, this method for constructing a set of injection gas pressure at depth curves should be satisfactory for most gas lift calculations. Only two injection gas pressures at depth must be calculated to establish a set of curves. These two pressures are based on the maximum and minimum injection gas pressures encountered during the unloading and gas lifting operation of a well or group of wells in the same system. Figures 1 and 2 (which also appeared in Part 1 of this series, WORLD OIL, August 1959) will be used to determine these pressures at depth.

The following problem example is presented to illustrate the procedure required for constructing a family of gas pressure at depth curves:

Step 1. Tabulate data required for constructing curves:
Range of injection gas pressure, P_w = 450 to 650 psig at surface
Injection gas gravity, G = 0.75
Maximum length of gas column, L = 6,000 feet
Average injection gas temperature at well, $T_w = 70°$ F.
Bottom hole temperature, $T_v = 106°$ F at 6,000 feet

Step 2. Calculate injection gas pressure at 6,000 feet for surface pressure of 450 psig:
Estimate pressure at 6,000 feet assuming 2.5 psi per 100 psig gas pressure per 1,000 feet of depth:
$P_v = 450 + 2.5(4.5)6 = 517.5$ psig
Use $P_v = 520$ psig
Therefore:

$$P_{avg} = \frac{P_w + P_v}{2} = \frac{450 + 520}{2} = 485 \text{ psig}$$

And:

$$T_{avg} = \frac{T_w + T_v}{2} = \frac{70 + 106}{2} = 88° \text{ F}$$

Determine compressibility factor from Figure 1 for $T_{avg} = 88°$ F and $P_{avg} = 485$ psig:
Z = 0.890
Determine pressure at 6,000 feet from Figure 2:
$P_v = 538$ psig
Recalculate average pressure:

$$P_{avg} = \frac{450 + 538}{2} = 494 \text{ psig}$$

Determine compressibility factor from Figure 1 for $P_{avg} = 494$ psig:
Z = 0.888
Determine pressure at 6,000 feet from Figure 2:
$P_v = 538$ psig

Step 3: Calculate injection gas pressure at 6,000 feet for surface pressure of 650 psig. (Average temperature is same as calculated in Step 2):
Estimate pressure at 6,000 feet:
$P_v = 650 + 2.5(6.5)6 = 747.5$ psig
Use $P_v = 750$ psig
Therefore:

$$P_{avg} = \frac{650 + 750}{2} = 700 \text{ psig}$$

Determine compressibility factor from Figure 1 for $T_{avg} = 88°$ F and $P_{avg} = 700$ psig:
Z = 0.847
Determine pressure at 6,000 feet from Figure 2:
$P_v = 782$ psig

Text continued on Page 82.
See graphs on Pages 74, 75, 76 and 77.

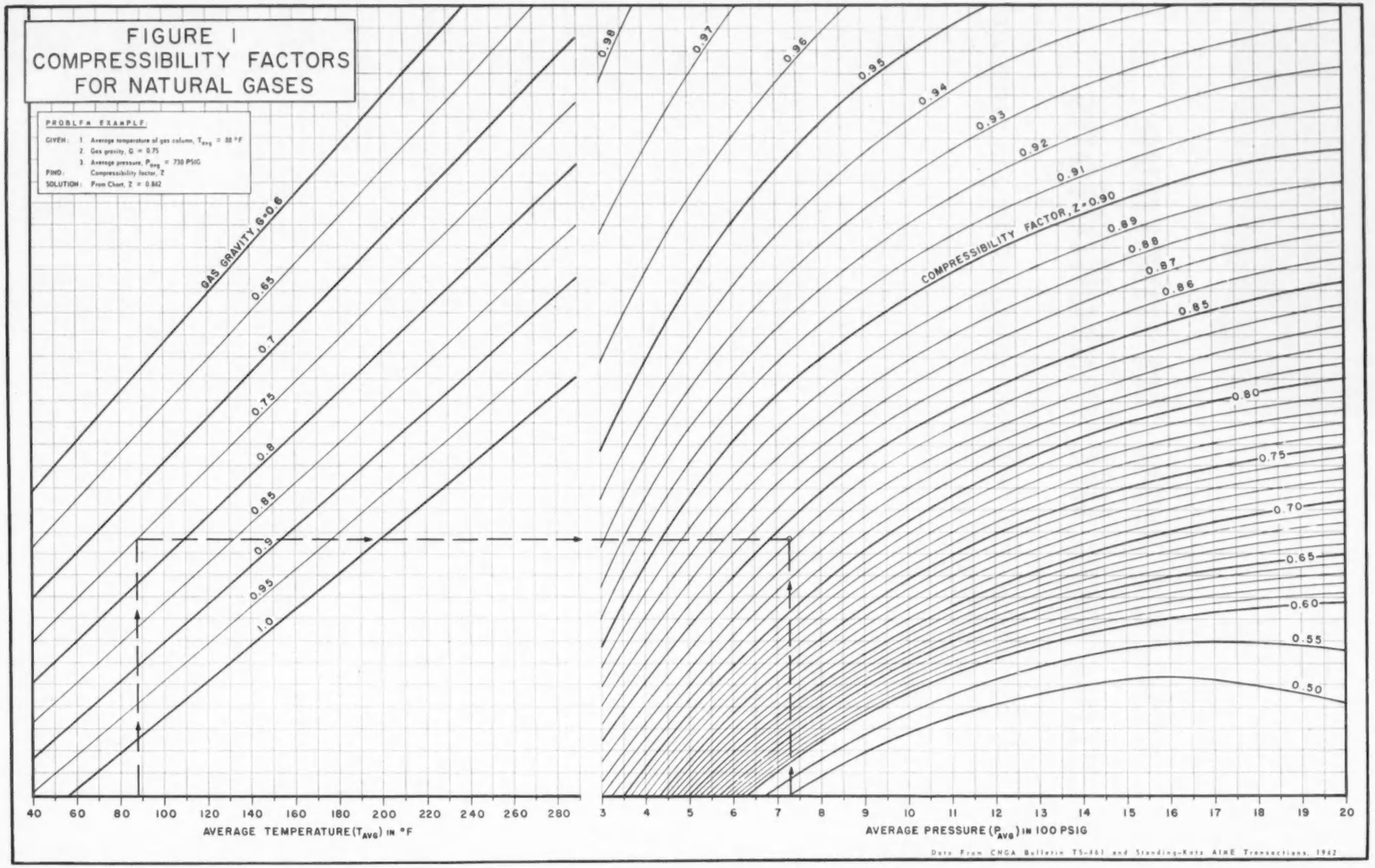


FIGURE 1
COMPRESSIBILITY FACTORS
FOR NATURAL GASES
PROBLEM EXAMPLE:
GIVEN: 1. Average temperature of gas column, T_{avg} = 88 °F
2. Gas gravity, G = 0.75
3. Average pressure, P_{avg} = 730 PSIG
FIND: Compressibility factor, Z
SOLUTION: From Chart, Z = 0.862
GAS GRAVITY, G=0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1.0
COMPRESSIBILITY FACTOR, Z=0.90
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.89
0.88
0.87
0.86
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
40 60 80 100 120 140 160 180 200 220 240 260 280
AVERAGE TEMPERATURE (T_{AVG}) IN °F
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AVERAGE PRESSURE (P_{AVG}) IN 100 PSIG
Data From CNGA Bulletin TS-461 and Standing-Katz AIME Transactions, 1942

FIGURE 2: GAS PRESSURE AT DEPTH

CHART BASIS EQUATION:

$$P_v = P_w (e)^{\frac{GL}{53.34\, T_{avg}\, Z}}$$

PROBLEM EXAMPLES:

1. GIVEN: Surface gas pressure, P_w = 650 PSIG
   Gas gravity, G = 0.75
   Length of gas column, L = 6000'
   Avg. temp. of gas column, T_{avg} = 88 °F
   Compressibility factor, Z = 0.845
   FIND: Pressure, P_v, at 6000'
   SOLUTION: From Chart, P_v = 783 PSIG at 6000'

2. GIVEN: Pressure at depth, P_v = 1025 PSIG at 11,000'
   Gas gravity, G = 0.67
   Avg. temp. of gas column, T_{avg} = 162 °F
   Compressibility factor, Z = 0.911
   FIND: Surface pressure, P_w
   SOLUTION: From Chart, $(e)^{\frac{GL}{53.34\, T_{avg}\, Z}}$ = 1.276
   From Figure 3 P_w = 800 PSIG at surface

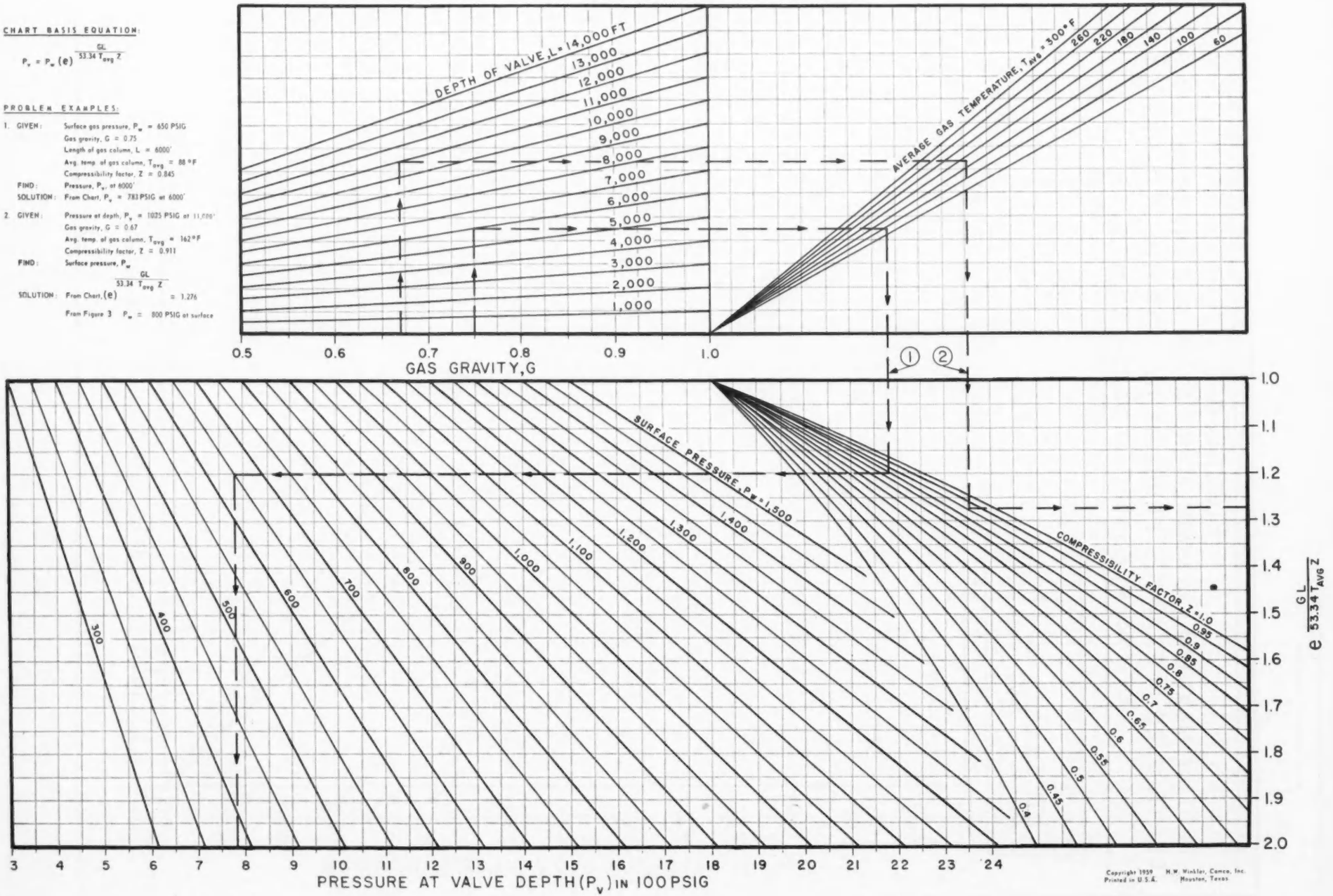


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FIGURE 4

PLOT OF MAXIMUM AND MINIMUM INJECTION GAS PRESSURE VERSUS DEPTH USED IN EXAMPLE PROBLEM ILLUSTRATING CONSTRUCTION OF GAS PRESSURE AT DEPTH CURVES

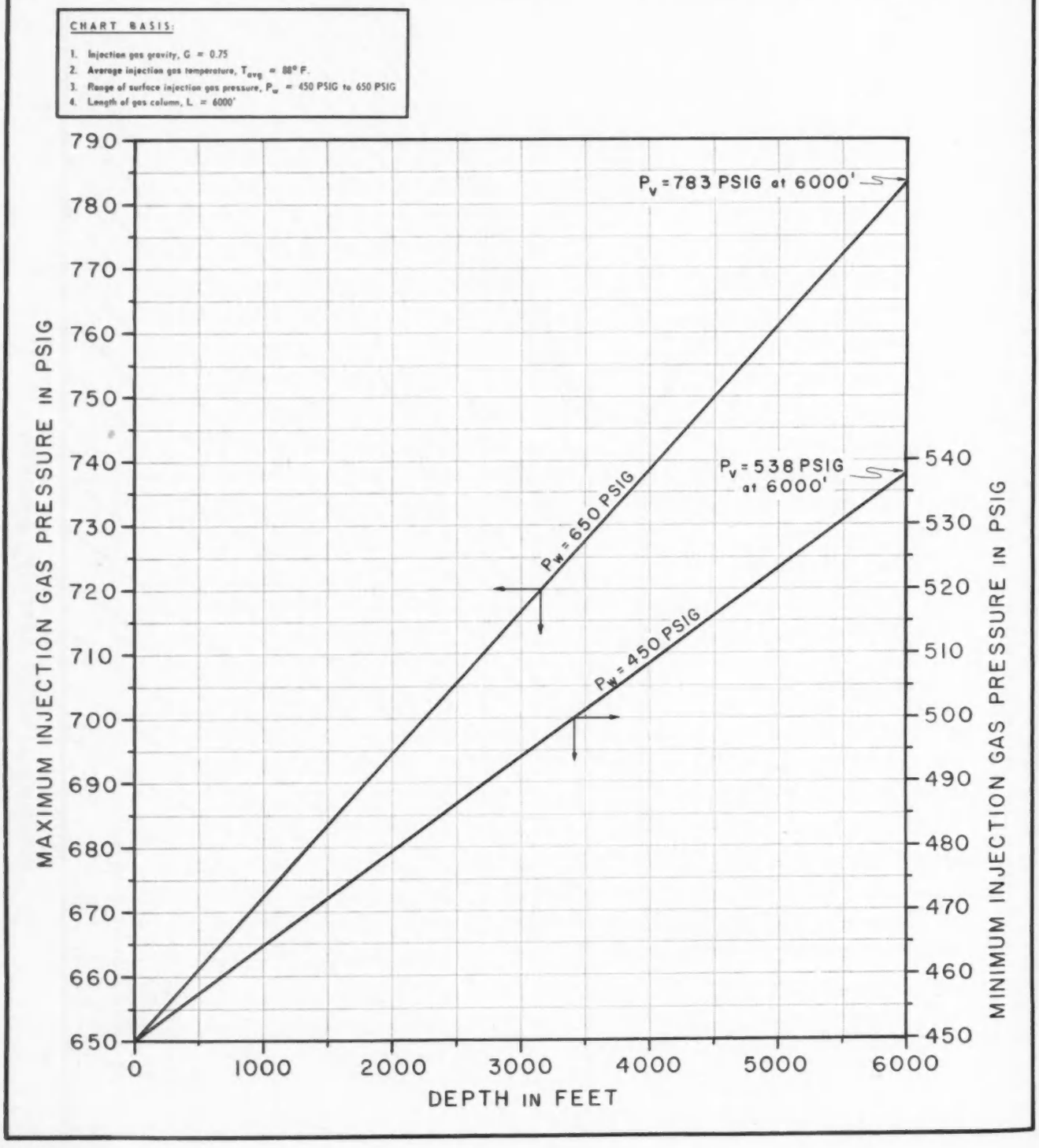
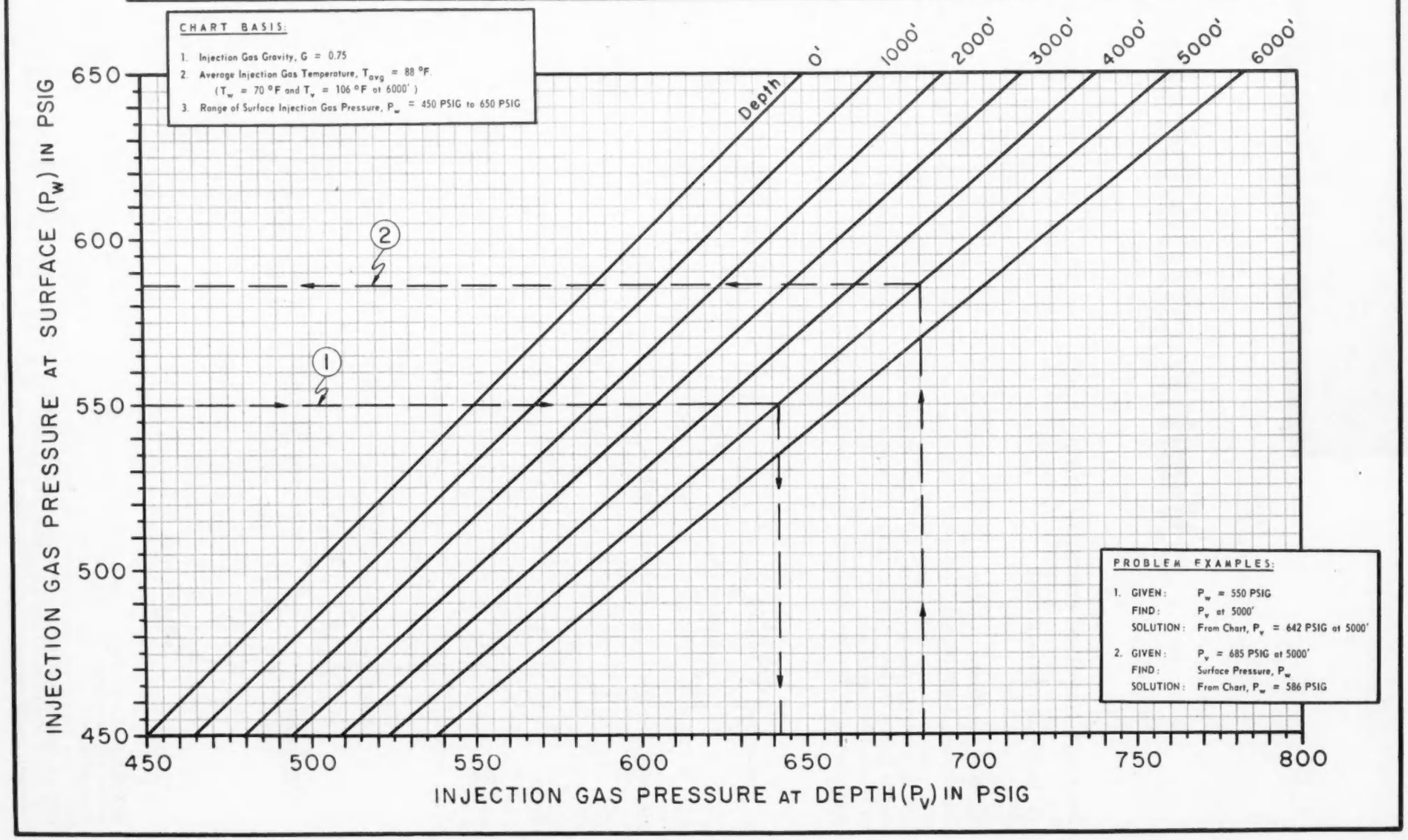


FIGURE 5

INJECTION GAS PRESSURE AT SURFACE VERSUS APPROXIMATE INJECTION GAS PRESSURE AT DEPTH FOR EXAMPLE PROBLEM ILLUSTRATING CONSTRUCTION OF GAS PRESSURE AT DEPTH CURVES



This article, the first of a series of four discussing specific oil prospective South American basins, describes the general geologic environment, tracing the movements of ancient seas. The areas of resulting marine sediments deposited and buried are shown and evaluated.

Part 1

Vast marine basins being

Seaways traversed continent during much of post-Cambrian time

By Carl A. Moore, Chairman, School of Geological Engineering, University of Oklahoma

THE EXPLORATION POTENTIAL of South America has hardly been scratched. Although some localities have been proved among the most oil productive in the world, scarcely any of the vast continent's basins have realized anything like their full potential. Some of them have not been drilled at all. Most of them are in various intermediate stages of development.

To present adequately the story of South American oil, a series of maps is included to illustrate the ancient seaways and sites of deposition during the many geologic periods. Information from these maps is used to evaluate individual countries and areas.

Lower Paleozoic era (Figure 1). So far the lower Paleozoic beds have not been generally considered prospective in South America. For this reason, most surface

FIGURE 1—Lower Paleozoic seas followed roughly the same pattern of deposition, recorded in sediments throughout the present-day Andes Cordilleran Front north of central Argentina and Chile. Deposition was continuous in Bolivia, with beds thinning toward both north and south. Some Devonian beds were also deposited in the Amazon trough. The Brazilian Shield remained prominently above sea level during Paleozoic time.

FIGURE 2—During upper Carboniferous—Permian (C) and upper Triassic (Tr) periods, sedimentary patterns began to change. Glacial deposits were widespread in northern Argentina, causing formation of tillite beds, some of which are oil-productive today. Sea level was lowered, and widespread deposits of continental and shallow mixed strata were laid down. Many lava flows occurred during the Triassic period.

explored in South America

geological work is carried only to the upper part of this sequence of rocks. Some data on these rocks have been obtained from a study of drill cuttings and cores.

From central Argentina southward there are no lower Paleozoic rocks. In northern South America, the lower Paleozoic seas extended northward from Peru across Colombia and only the western part of Venezuela, as shown in Figure 1.

These lower Paleozoic seaways deposited dark marine shales with few beds of sandstone. There are limited limestones in north-central Argentina and central Colombia. Since the old Paleozoic troughs have been folded into high mountains, thick sections of Paleozoic shales and sandstones are now metamorphosed into slates and quartzites.

Each one of the lower Paleozoic seaways extended across Bolivia, and studies show that each Paleozoic period is represented there in maximum thickness. There was probably more or less continuous deposition in Bolivia, and the lower Paleozoic sediments thin both northward and southward. They thin abruptly toward the south, and cover broad extensive areas to the north. Northward thinning is less pronounced and less well known since Devonian beds are covered by younger sedi-

FIGURE 3—Drastic changes took place during Jurassic times, when a broad westward tilting occurred on a continent-wide scale. Except for localized Bahia Basin, the entire eastern part of the continent was above sea level, and sediments were laid down along most of the present-day west coast. Some lower Cretaceous beds are included here, notably in Tierra del Fuego, undergoing marine deposition for the first time.

FIGURE 4—More general submergence occurred during middle Cretaceous (M.K.), upper Cretaceous (U.K.), and Paleocene (Pa) transition period. Older Jurrassic seas on west generally spread eastward. Eastern Venezuela received its first marine deposition. To the extreme south, some marine waters engulfed Tierra del Fuego and parts of Patagonia. Marine beds were laid down in the present-day Bahia coastal strip of Brazil.

FIGURE 5—South America began to assume its present-day configuration during middle and upper Eocene (E), Oligocene (φ), and lower Miocene (L.M.). Andes Mountains uplift was underway, raising present-day Cordilleran region above sea level, and causing widespread deposition of continental and mixed beds. Marine Eocene beds were deposited in the Lake Maracaibo area, giving rise to prolific oil deposits.

FIGURE 6—Northwestern and northeastern Venezuela were sites of heavy marine deposition during middle Miocene (M.M.), upper Miocene (U.M.), and Pliocene (P) epochs. Most of the oil produced so far in South America has come from Tertiary formations. Magdalena Basin of Colombia shows as a prominent feature. Widespread deposition of terrestrial facies followed uplift of the Andes Mountains.

ments of the sub-Andean area immediately east of the mountains.

Where the lower Paleozoic rocks are metamorphosed in the high mountains, there is not much likelihood of production. However, in many areas immediately east of the Andes there are many hundreds of feet of unmetamorphosed dark gray marine lower Paleozoic shales and sandstones which must be ultimately considered as possible sources of oil.

Upper Paleozoic—Triassic periods (Figure 2). Seaways of the upper Carboniferous—Permian (C), and upper Triassic (Tr) periods followed the lower Paleozoic seaways to some extent, from northern Colombia southward across Ecuador, Peru, and into Bolivia. The southern limit of this marine deposition is shown to be approximately across central Bolivia. Marine Carboniferous rocks are present along the coast of central Chile, and in the Amazon trough. In the Maranhão Basin of northeastern Brazil these sediments are shown to be shallow water marine and brackish deposits that are called "mixed" on the map.

Of particular note is the widespread period of continental glaciation during the Permo-Carboniferous period. This was one of the great periods of glaciation in the geological record. Much evidence has been obliterated by subsequent erosion and deposition. But in southeastern Bolivia, northeastern Argentina, Paraguay, Uruguay, and southern Brazil evidences of this abnormal climate, such as glacial striae (enabling one to follow the direction of ice movements), and tillites are found. Interbedded with the tillites are significant beds of shales, dark gray to black pyrobituminous, called the Irati shales. These seem to indicate the tidewater position of these glaciers relative to local sea invasions between successive advances of the glacial ice.

SIGNIFICANT OIL PRODUCTION has been found in the Permo-Carboniferous tillites of southern Bolivia and northern Argentina in anticlinal structures which were uplifted following the deposition of these glacial deposits. Sources of this oil are not definitely known. Source beds may be associated black shales, or underlying Devonian dark marine shales. This aspect lends much to the importance of these deep, lower Paleozoic dark marine shales and sandstones as source rocks for oil along the sub-Andean front. The dark shales with minor interbedded limestone beds in northern Argentina might well be of even greater significance as source rocks.

Marine upper Triassic rocks are limited to the Ecuador-Peru-Bolivia portion of the Andes Mountains. Northward into Colombia, the Triassic is represented by non-marine sediments. The Roraima sandstone of Triassic age covers a large area in southern Venezuela, extending into northern Brazil and southeastern Colombia. After a long period of controversy over the age of his unique sandstone, it is now generally accepted as being of Triassic age.

The Paraná basin contains non-marine Triassic sedi-

FIGURE 7—Present basin areas of South America are shown in this composite of maps 1-6. Prominent features are Orinoco (East Venezuela), Barinas-Apure, Zulia, Magdalena and Pacific basins in the north and northwest; Amazon, Maranhao, Bahia, and Parana basins in Brazil; and sub-Andean trough from Colombia through Argentina and southeastward to the east coast. Maps 1-7 are all modified from Weeks, 1947.

ments that appear to be a continuation of the mixed deposits of southeastern Bolivia and Paraguay. Southward into Argentina, the Triassic is mixed and then becomes non-marine in the Patagonia area.

During the Triassic one of the greatest outpourings of basic lava on earth occurred in the Paranà basin. These flows have effectively obscured the geology of the basin except around the edges. There are some interbedded sandstones in the lava flows. Extent of these flows is illustrated in Figure 2. They cover over 300,000 square miles, with a volume in excess of 50,000 cubic miles. (Baker, 1923). The flows are vesicular, cavernous and dense, with some columnar structure. No indications of volcanoes have been found, hence it is assumed that the great flows resulted from fissure eruptions, probably throughout the area now covered by the flows. Composition of the lavas range from andesite to olivine-free augite porphyries.

Jurassic period (Figure 3). Following the Triassic period there was a major re-alignment of the depositional troughs in South America. The lower and upper Paleozoic seas were confined to essentially the same areas. Beginning with the Jurassic there was a broad westward tilting on a continent-wide scale. No longer did any seas invade the eastern part of the continent. The area now occupied by the present Andes Mountains and the sub-Andean area east of the mountains were flooded by marine waters during practically the entire Jurassic period.

In these Jurassic seaways were deposited dark, organic shales and some limestones. These were deposited under reducing conditions, and in zones of poor circulation. Any organic material in this sea would have been preserved. Today these Jurassic marine shales are believed to be a significant source of oil along the Andean mountain front.

Northward, in Colombia and western Venezuela, land conditions prevailed, and upper Jurassic to lower Cretaceous red beds were deposited. These beds are found resting on either older sediments, or on basement rocks of Pre-Cambrian and/or lower Paleozoic age. Drilling is not normally carried into these red beds.

THE FIRST DEPOSITION in the Bahia embayment of eastern Brazil, and in the Tierra del Fuego area of southern Chile, occurred during the Jurassic period.

Cretaceous period (Figure 4). The major sea advance of the Mesozoic occurred during the middle Cretaceous. A number of new areas receiving deposition may be pointed out:

- First marine deposition in eastern Venezuela
- Widespread marine conditions in western Venezuela, most of Colombia, extending southward across Ecuador and Peru through Bolivia to Paraguay
- Extensive but thin non-marine sediments of upper Cretaceous age on the Brazilian shield area
- Marine sediments in the Bahia area, extending in a thin band northward along the coast
- Continuation of marine conditions in the southern tip of Argentina and Chile, extending across Tierra del Fuego.

The Cretaceous sediments consist of marine shales with interbedded marine limestones and well-developed sandstone beds. Hence these beds are considered as major sources of petroleum, as well as providing the necessary reservoir rocks to accumulate oil. The combination of favorable marine conditions followed by structural movements gives this sequence major importance for oil exploration along the eastern flank of the Andes Mountains.

One factor of Cretaceous sedimentation is quite evident: starting with the limited Jurassic deposition (Figure 3), the Cretaceous seas spread out and reached their maximum marine development in middle to upper middle Cretaceous. By upper Cretaceous there were mixed marine and brackish water conditions prevailed in parts of Colombia and in western Venezuela. In the central Andean area of Ecuador and Peru, the entire Cretaceous and Paleocene sequence is marine.

There is a transition period between the Cretaceous and Eocene. The nature of the deposits of this transition period, here called the Paleocene, depends on the local depositional and structural history.

As shown in Figure 4, deposits of the Paleocene are transitional between the marine to brackish sediments of the upper Cretaceous and the predominantly non-marine Tertiary sediments. The most significant change was brought about by the first major Andean mountain movement during lower Eocene. This uplift elevated most of the present Andean chain so that subsequent deposits east of the Andes Mountains were non-marine. Only along the coast lines of Venezuela, Colombia, Ecuador, Peru and southern Chile, and small coastal strips of Brazil were marine lower Tertiary beds deposited.

Lower Tertiary period (Figure 5). Following the first major Andean movement at the beginning of the Tertiary

period, South America began to assume a modern aspect. The Andes Mountain chain was emplaced; the Brazilian and Guiana shields were locally covered by non-marine deposits; Patagonia was stabilized, and the southern tip of Chile was emergent following the marine conditions of the Mesozoic. Lower Tertiary marine sediments were limited to the edges of the continent, to northern Colombia, and much of Venezuela.

Southward, along the Magdalena and Sinu rivers in Colombia, these marine sediments become mixed with brackish to non-marine strata. The sandstones have become good reservoir rocks, drawing oil from the interbedded marine shale source beds. Most of the oil in Colombia has come from these mixed lower Tertiary beds.

Following the first Andean movement, there were some low areas between the newly uplifted ranges in which lower Tertiary rocks were deposited. Succeeding uplifts have incorporated these lower Tertiary rocks into the main mountain chain.

Along the west coast of South America, northward from Peru, is the Bolivar geosyncline (Nygren, 1950). This is a series of downwarps, or sinks, in which the marine Tertiary sediments are locally thickened.

Upper Tertiary period (Figure 6). Rocks of this sequence were deposited following the second and third major Andean movements. With these great uplifts, accompanied by outpourings of igneous material, all of the upper Tertiary sediments east of the Andes are non-marine, the result of outwash from the new mountains. Successive sheet-like non-marine sediments cover the Brazilian and Guiana shield areas.

Around the edges of the continent, from Brazil southward to Argentina and thence northward to Peru, the upper Tertiary sediments are non-marine. There are small areas of marine and mixed sediments along the west coastal areas of Chile and Peru.

North of Peru, the Bolivar geosyncline was filled with thick marine sediments. This area of marine deposition extended along the northern coastal area of Colombia as far east as the Sierra Perija. In central and eastern Colombia all the upper Tertiary beds are non-marine.

Northwestern and eastern Venezuela were the sites of extensive upper Tertiary marine deposition. Lake Maracaibo, a closed basin that opens northward to the Caribbean Sea, received thousands of feet of upper Tertiary sediments which have produced and are producing the major amounts of oil in Venezuela and in South America. In eastern Venezuela the marine Oligo-Miocene Oficina formation is the chief oil producer, with the Pliocene Quiriquire formation producing in one major field.

Following the fourth Andean movement during the Pleistocene, the South American continent assumed its present, modern configuration.

(Editor's Note: References cited will be published at the conclusion of this series.)

Part 2, discussing specific South American areas, including Argentina, Chile and Paraguay, will appear in a coming issue of WORLD OIL.

About the Author

Dr. Carl A. Moore is professor of geology and chairman of the School of Geological Engineering, University of Oklahoma. He received his Ph.D. from the State University of Iowa in 1940. He was employed by Standard Oil Development Co. from 1940 to 1942 as research geologist on foreign oil basins, and from 1942 to 1946 as field subsurface geologist in Oklahoma for the Carter Oil Company. Since 1946 he has been at the University of Oklahoma teaching subsurface geology, petroleum geology, and the geology of South America. In August 1957 he was one of eight professors selected by the Creole Petroleum Corp. to visit Venezuela.

Here's how to improve your gas lift installations

Continued from Page 77

Recalculate average pressure:

$$P_{avg} = \frac{650 + 782}{2} = 716 \text{ psig}$$

Determine compressibility factor from Figure 1 for $P_{avg} = 716$ psig:

$Z = 0.844$

Determine pressure at 6,000 feet from Figure 2:

$P_v = 783$ psig

Step 4. Select suitable scales for depth (length of gas column), minimum and maximum gas pressures from surface to maximum depth, and draw and label coordinate axes as shown in Figure 4. Plot injection gas pressure at depth (6,000 feet in this example) for maximum and minimum surface pressures. Draw a straight line between maximum gas pressure at surface (zero feet) and maximum gas pressure at depth (6,000 feet). Follow same procedure for minimum gas pressure.

Step 5. Tabulate injection gas pressure at various depths for both maximum and minimum injection gas pressures. Obtain these pressures at depth from Figure 4.

Depth in Feet	Pressure at depth (P_v) in psig	
	(P_w = 450 psig)	(P_w = 650 psig)
0	450.0	650.0
1000	464.6	672.1
2000	479.4	694.3
3000	494.0	716.4
4000	508.7	738.6
5000	523.3	760.8
6000	538.0	783.0

Step 6. Select scales for injection gas pressure at surface versus injection gas pressure at depth and draw and label coordinate axes as shown in Figure 5. For surface pressures (P_w) of 450 psig and 650 psig, plot injection gas pressure at depth for each depth assumed in Step 5. Connect both points for each depth with straight line and identify these depth lines. This completes the gas pressure at depth curves.

The curves in Figure 5 can be used to determine the gas pressure at depth for a given surface pressure or to determine gas pressure at the surface if the pressure at depth is known. The use of Figure 5 is illustrated by the dashed lines and example problems on the chart.

—The End

How to select and maintain drilling generators

The basic types and characteristics of direct current generators must be thoroughly understood

By O. J. Graham
Application Engineer
General Electric Company, Schenectady, N. Y.

THE GENERATOR is a vital link in the chain of power transmision on a diesel electric drilling rig. Therefore, great care should be taken to be sure that the proper generator for the job is selected. Even after the generator is properly selected this link in the power transmission chain will be strong only as long as it is given sufficient maintenance to keep it in good operating condition.

Since all the loads on a drilling rig require a great variety of speed-torque characteristics along with accurate control of speed, direct current motors and generators are a must. Alternating current systems have been used but considerable costly and complicated controls were required to approach the speed control accuracy of a direct current system. Therefore, only a D.C. system will be considered here.

Basically the load requirements on a drilling rig are the same for all functions. There should be a speed limit, a torque limit and a power limit. On a direct current generator, these limits can be realized by limiting the volts and amperes. The power must, of course, be limited by the available engine power. An ideal generator curve is shown in Figure 1.

Factors involved in the selection of generators. The most important factors that should be considered when selecting a generator are:

- Characteristics.
- Simplicity of the excitation system.
- Construction.
- Size, weight and rating.
- Cost.
- Reliability.
- Availability of parts and service.

Characteristics. There are three general types of D.C. generators, shunt, series and a combination of the two, a compound generator. If the excitation is produced by a winding that is connected to full or nearly full line voltage, the machine is known as a shunt generator. This field may be excited from the terminals of the generator or from an external source. The schematics and characteristics of this type of generator is shown in Figures 2A and B. Neither of these machines are ideally suited for oil well drilling without external control because there is no definite current limitation.

Figures 2C shows the characteristics and schematic diagram of a theoretical series generator. A series generator without any shunt winding would not be practical since the voltage output increases as the load increases. Therefore, this is only a theoretical case and cannot be considered as practical.

Figures 2D shows the schematics and characteristics of compound wound generators with varying amounts of compounding. The solid curve shows the differentially compounded generator. The power limit can be obtained by the use of a load control governor or by stalling or lugging the engine. As the engine is overloaded the speed drops, however, the generator unloads approximately as the square of speed. Consequently, for any given amount of overload the engine speed will settle out at somewhere below rated speed. This system has been used satisfactorily on industrial locomotives for several years.

Another way of obtaining the characteristic as shown in Figure 2D is by using self separate excitation. With this system, the shunt field receives excitation from itself and from a separate source. This gives essentially the same characteristic, but without the series differential field the current limit is not as definite.

There are many ways of obtaining the desired characteristic with control devices and exciters but the cost and complexity to the system is increased.

The excitation system on any drilling rig should be as simple as possible. It should be simple enough to be understood by persons who are not specifically trained to understand complicated circuit diagrams. This would appear as though a generator which has the inherent characteristics built into it would be the best in most cases. However, a generator which has sufficient control to put artificial current and voltage limits on it will do a good job.

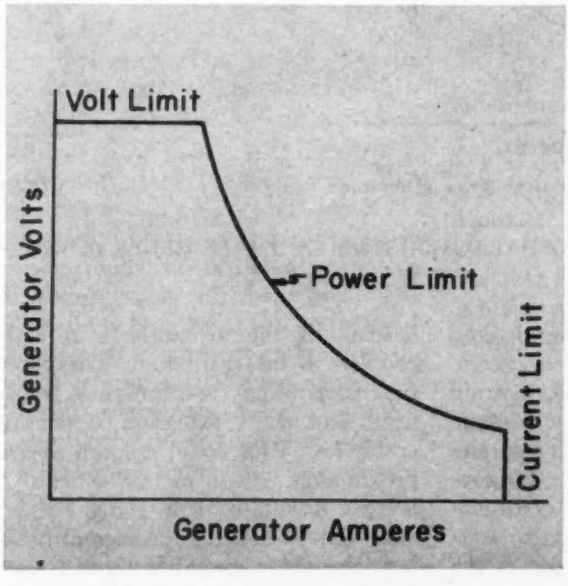


FIGURE 1—An ideal generator type curve.

Construction. There are two basic types of generator mechanical construction available for application as an engine driven generator for oil well drilling. These are (1) close coupled, single bearing type as shown in Figure 3 and (2) a two bearing, foot mounted type that may or may

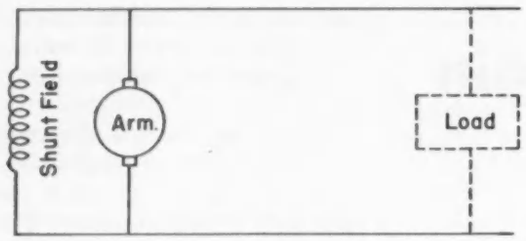
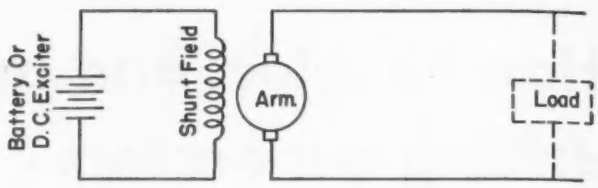


FIGURE 2A—Shunt generator.



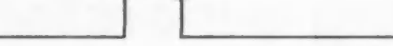


FIGURE 2B—Shunt Generator.

FIGURE 2C—Theoretical series generator.

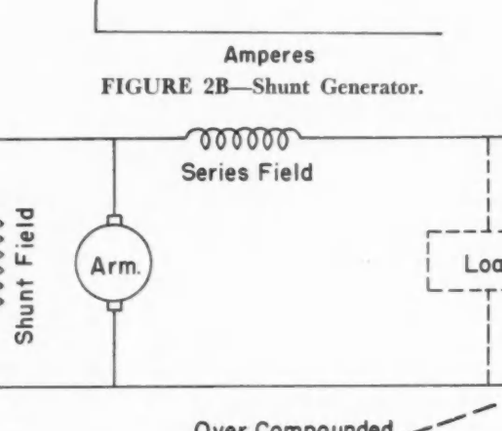


FIGURE 2D—Compound generator.

SCHEMATICS AND CHARACTERISTICS OF THREE GENERAL TYPE DIRECT CURRENT GENERATORS.

not be very similar to the drilling motors as shown in Figure 4.

The close coupled, single bearing type of generator has an advantage over a two bearing generator in size and weight. With this type of generator the frame is bolted to the engine either on a bell housing or to a flange. The weight of one end of the armature is carried by the engine bearing as the armature is directly coupled to the crankshaft. The space that is required for a bearing, frame head and shaft extension is considerably less. This could amount to approximately 4 to 6 inches, depending on the generator size being considered. The weight of the second bearing, the shaft extension and frame-head is also a savings. This is, in most cases, not particularly important on a barge or offshore rig but this size and weight savings is very important on trailer mounted rigs where the engine generator set size is of prime importance.

The two bearing generator also has the advantage of a minimum critical lineup. A highly skilled mechanic is not needed to obtain the degree of

lineup accuracy required with this type of construction. Whereas with the single bearing generator the air gap is dependent on the accuracy of the lineup.

The single bearing generator is somewhat limited as to the speed it will run. Also it requires a definite mounting arrangement which will tend to limit the engines on which it can be used. Thereas the two bearing generator is more versatile. It can be mounted on any engine with the proper coupling and if the engine speed is wrong for the generator a gear unit can easily be installed between the engine and generator.

An advantage of most single bearing generators is the ventilation system. Most of the single bearing generators on the market for oil well drilling have a fan on the shaft for ventilation and are generally considered self-ventilated. No additional equipment is needed for cooling of the generator. On the other hand most of the two bearing generators available require a separate motor driven blower for ventilation. This, of course, increases the cost of two bearing generators.

Both types of generator construction have their advantages and disadvantages but for a given generator size and assuming equal production quantities, the single bearing close coupled generator should cost less than the two bearing machine.

Most of the generators available for oil well drilling rigs are either traction type generators, designed for diesel electric service on locomotives or field coils, and a foot mounted frame. These machines are built rugged to withstand the abuse they must take on the railroads. Therefore, as a rule the traction type equipment should, at least mechanically, give as good or better service than most commercial machines.

Size, weight and ratings. The size and weight of a generator are more important considerations on a land rig than on an offshore rig because of width and weight restrictions.

In order to keep the weight and size to a minimum for a given power, the materials in a generator must all be used to the utmost. This means that the current density in the copper must be high and the flux densities in the iron of the armature core, frame and poles must also be high. This means that the operating temperature of the generator will be high and also that the copper temperatures may increase to 185-205 degrees Centigrade or 160 to 180 degrees Centigrade rise above ambient. On most industrial equipment the temperature rises are very conservative at 120-130 degrees centigrade. In order to run at these elevated temperatures, the generator must be constructed with high temperature insulations. These high temperature insulations are classified as Class "H" insulations. As previously mentioned, both size and weight can be saved by using a close coupled single bearing generator. This will save the extra length and weight of the fan end bearing. The weight of half the armature must then be carried by the engine bearing.

The generator of course must have sufficient rating to absorb the full engine output or its proportional share if there is more than one generator being driven by the one engine. The maximum operating speed of the generator must be compatible with the engine to be used. Also, the generator must be designed in relationship to the voltage and current of the motors on the rig.

Cost. One of the most important factors to consider in selecting a generator is to select a generator which will give a maximum performance at a minimum initial and maintenance expense.

In order to get this, the generator must be one which is not too conservatively rated, because the less weight of material per kilowatt output, the less the total cost for a given size generator. This means that the generator will run at a higher temperature with less weight per kilowatt.

Another factor which will affect the cost is the production rate of the generators. If a generator is to be custom built for an operator the cost is going to be extremely high. This is partially because of the added engineering effort that must go into the product and partially because of the limited production. The best price is going to be on a generator which is in high production, one which is an off-the-shelf item. One case of this is the wide usage of traction type generators which are in high production for use on locomotives. These are rugged machines designed specifically for being driven by a diesel engine. In some instances the traction motors have been modified to be used as generators and are the same as the drilling motors except for different exciting field coils. These are possibly not optimum generator designs but they have done an excellent job and almost all parts are interchangeable with the motors. This is an important consideration in the parts stocking problem.

Reliability. A generator is effective on a drilling rig only if it is reliable. It must be capable of running for extended periods of time under adverse weather conditions with a minimum of attention.

In order to assure reliable performance, the generator should be constructed ruggedly so as to withstand the vibration caused by the engines and in the case of land rigs, the vibration and abuse brought about by moving the rigs frequently.

The generator should be constructed so as to be protected against damage by rain and snow or dirt. If the generator is ventilated, either by its own fan or by a separate blower, and operated in a sandy wind blown area, provisions should be made for filtering the air. This will minimize the sand blasting of insulating materials or the high rate of brush wear.

Availability of parts and service. Parts availability should be very important in making a decision as to which generator would best fit the particular requirements. Most operators do not wish to stock enough parts to take care of any emergency which might arise. Before deciding on a specific generator, be sure that supplies, repair, and service facilities are readily available.

Running maintenance and inspections. The life of electrical rotating equipment depends to a great extent on the inspection and maintenance schedules. On any D.C. machine the commutator, brushes, brushholders and bearings are the parts which will require the most attention. The amount of attention that any particular part should receive will vary somewhat, depending on local atmospheric and climatic conditions as well as the machine construction. Different manufacturers will specify their own inspection and maintenance

schedule, depending on past experience with their equipment. However, the following general maintenance procedures and schedules should generally apply.

For the first week after D.C. generators are placed into service, it would be well to open and inspect the commutator chamber every day or so. This should, of course, be done only with the engine shut down and all power removed from the generator. Look at the commutator for any unusual coloring or burning conditions. Look at the brushes for signs of breakage or excessive wear. Look for excessive carbon brush dust or excessive foreign material which might be collecting. If clean dry compressed air is available, direct a hose into the commutator chamber and blow out all loose dirt. While blowing out the generator, the generator should be rotating slowly. Monthly or 500-hour inspections should be made following the first three weeks of operation. The following is a suggested monthly inspection routine for D.C. generators.

Monthly inspection routine

- Remove covers and blow out interior of generator with clean dry compressed air. Wipe off any oil or grease with a cloth dipped in an approved cleaning solvent.
- Inspect the commutator and wipe off the string band at the outboard end of the commutator. The commutator surface must be free of copper beads and have a smooth uniformly polished appearance. Clean and resurface it when necessary.
- See that the brushholder mechanisms operate properly, that brush shunts and terminals are tight and that insulators are clean and in good condition.
- Check brushes for wear. Replace any which are broken or worn near the permissible limit. Be sure that all brushes move freely in their holders and are not stuck with dirt or other foreign material. When replacing brushes use only the recommended grade. Mixing of brush grades in the same machine or changing grades could seriously affect commutation, surface film and brush life.
- Check brush pressure. If there is any adjustment it should be adjusted if need be. Recommended pressures will vary depending on commutator surface, speed, brush grade, etc. Check clearance between bottom of brush holder and surface of commutator. Machine manuals should give the recommended clearance.
- Examine armature, field coils and connections for cracked, charred or broken insulation. Be sure all connections are tight.
- Add grease to the bearings if instructed by the manufacturer. Many generators are now built with sealed bearings that require lubrication at overhaul or approximately every three years.

General Maintenance and overhaul. At the end of each 6,000 hours of operation or once a year, in addition to the monthly running maintenance inspections, the insulation resistance should be tested according to the manufacturer's maintenance instructions.

If the commutator is dirty, blackened or only slightly rough, use 00 sandpaper (or finer grade) and sand surface by running the generator at approximately ⅓ normal speed and holding the sandpaper against the surface with a light even pressure. Work it back and forth longitudinally until the surface is clean. Then blow out the dust with dry, clean compressed air.

If the commutator has undergone mild flashovers, grooving or burning, the commutator should be stoned (see a maintenance manual for instructions).

If the surface is badly worn, burned or scarred, the armature should be removed from the frame and placed in a lathe, preferably mounted in its own bearings. The commutator should then be turned, undercut, and then ground and polished.

At the opposite end of the commutator bars from the armature core there should be a string band. In most machines this is just what the name implies, a band of string which acts to hold mica insulation in place and acts as a creepage surface between the commutator segments and ground. This should be painted with an insulating paint. Clean this good and if necessary give it a coat of insulating paint.

In addition to the monthly and yearly maintenance, approximately every three years or 18,000 hours of operation, the generators should be removed, disassembled, inspected and reconditioned as necessary. In most machines this should include varnish treatment of the armature and field coils. Also in many machines manufactured in recent years the bearings are packed with grease when built and are not equipped with fittings to be used periodically for greasing. These machines should have the bearings repacked with grease while the machine is disassembled.

All that is given here is a rough idea of what is considered to be a

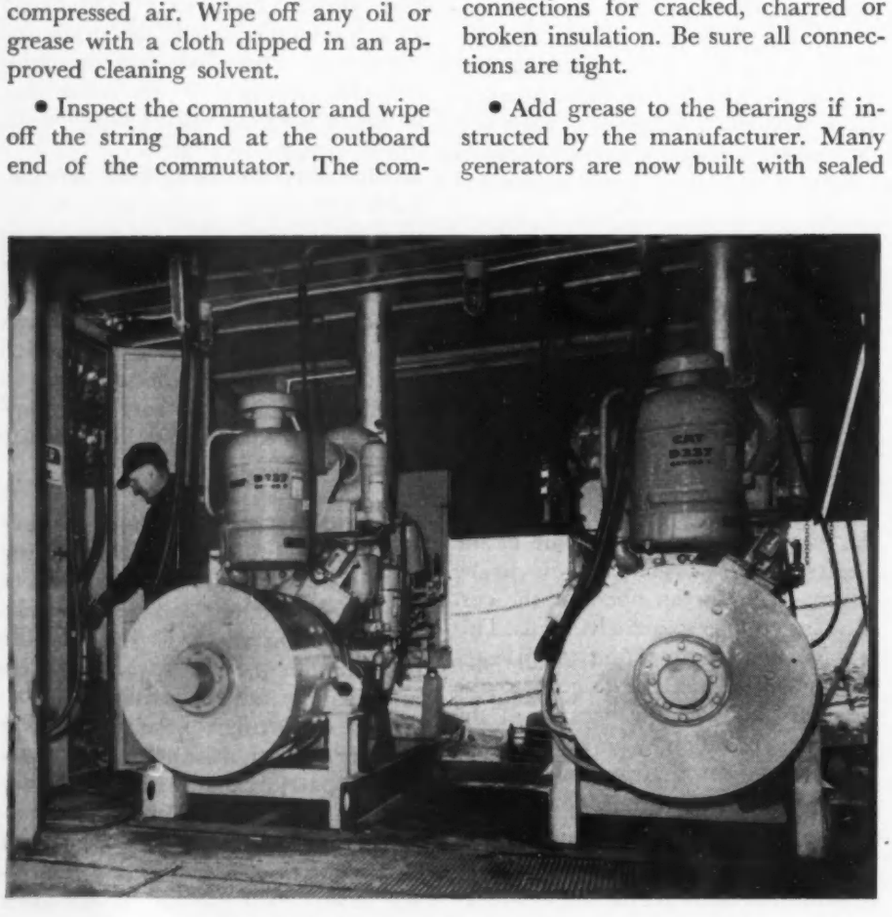


FIGURE 3—A closed coupled single bearing generator.

minimum of maintenance. The most troublesome parts of a D.C. generator are the commutator, bearings, brushes and insulation and should be given the most attention.

Summary. The criteria for properly selecting a generator may be resolved by asking the following questions:

- Does this generator inherently give the required characteristics? If not, is the control necessary to give the required characteristics going to be reliable and easy to maintain by the rig personnel?
- Is the generator power capacity and operating speed compatible with the engine to be used? If the speed is wrong will a gear unit be practical?
- Are the generator current and voltage ratings compatible with the ratings of the motors used to drive the various functions?
- How does the initial cost of this generator compare with others considered?
- Have other users of this generator had good service from it?
- Is it built rugged enough to withstand the service expected of it?
- Is there going to be an easily accessible supply of parts that can be obtained in a hurry?
- Is this generator adequately protected against the weather or will it cause trouble?
- Are the dimensions suitable for the allocated space?
- Is the machine too heavy for the position in which it is to be mounted?
- Can the generator be mounted so that the brushes and commutator are easily accessible?

If the answers to these questions are "yes" then this generator should be satisfactory for your application.

The general and preventive maintenance and likely vulnerable spots of a D.C. generator are summed up and discussed below:

1. Commutator—This can tell a story providing you are familiar with what to look for. Some of the symptoms, causes and treatments are as follows:

- Threading—Fine grooved lines that are cut on the commutator surface. The most common cause is extended light load operation (long periods of engine idling).
- Bar marking, etching and burning—This is a discoloration, etching or burning of the trailing edge of the commutator bar. It results from arcing between the brush and that portion of the segment, easily visible to the eye.
- Copper drag—Small flakes of metal that appear mainly on the trailing edge of the commutator bar. This can lead to shorted commutator bars. Cause is not specifically defined but occurs when conditions are right.
- Raised bars—Bars actually raise a small amount above the others so that the brush surface is rough. Can cause brush breakage and poor commutation. This condition is caused by a poorly seasoned commutator, or excessive localized heating (high current through brushes and commutator bars without rotation of commutator).

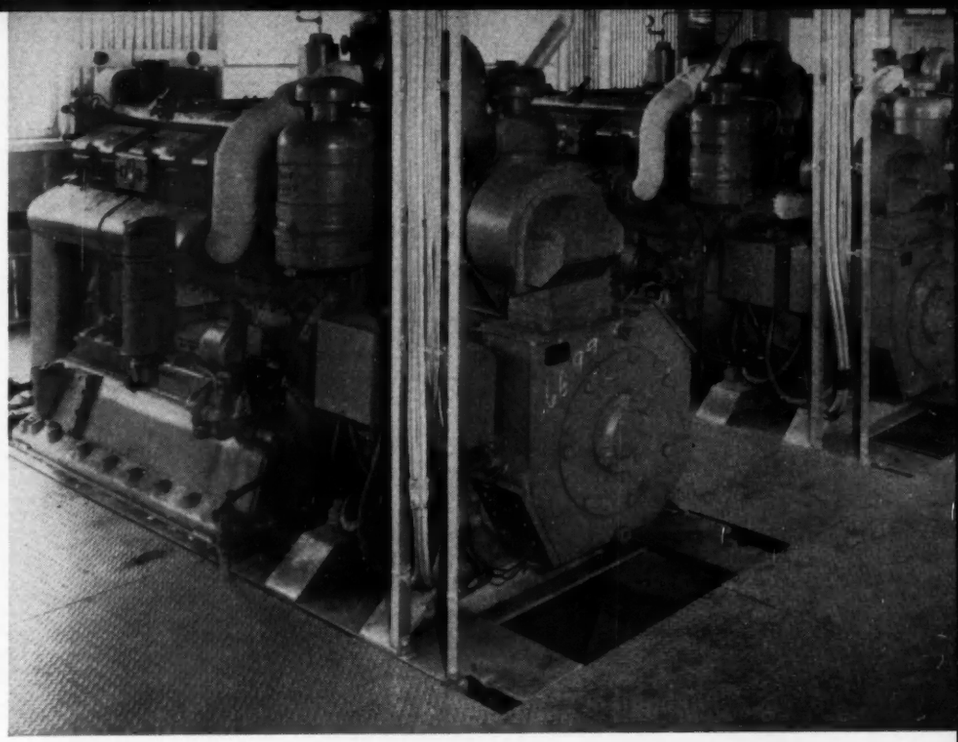


FIGURE 4—A two bearing foot mounted generator with a converted traction motor.

2. Brushes—If any of the following conditions are observed, attention should be given immediately.

- Chipped edges—This is an indication of a rough commutator or severe sparking.
- Broken brushes—This could be a rough commutator, severe vibration or rough handling during checking or changing of brushes.
- Excessive wear—Excessive sparking can cause this or the wrong brush grade; operation in excessively low absolute humidity atmosphere, or dusting; operation without field on the generator for extended periods of time; low brush pressure.
- Broken pigtails—Most D.C. machines use brushes which have a copper shunt attached to them to connect to the brush holder body. If this pigtail is broken, the current must still get from the brush to the brush holder either through the brush holder spring or directly from the brush. If it goes through the spring it may cause a loss of spring pressure. If it goes directly from the brush to the brush holder, it may erode the inside of the brush box causing it to be rough. This can lead to stuck brushes which will damage brush holders.

3. Insulation—In order to make the generator operate properly, the insulation must be sufficient between windings and also between the windings and ground. Dirt will provide a creepage path to ground and will eventually cause trouble. Remove all dirt from the inside of the generator as often as possible.

4. Bearings—These should cause very little trouble on most generators. At overhaul they should be repacked with grease if they are sealed bearings. If not, they should be greased as specified. Look for noisy bearings, hot bearings, or resultant excessive vibration.

There are other parts of the generators that might give trouble, but the majority of trouble will be found in the four items mentioned here.

Remember! Select the proper generator for your application, give it proper preventive maintenance and it will be reliable for many years.

—The End

FIGURE 1—The southwestern district of the Michigan Basin comprises 11 counties covering an area of nearly 6,748 square miles. Records* indicate nearly 6,565 exploratory and field wells have been drilled throughout the district. The greatest number of wells have been drilled into Devonian formations, principally the Traverse limestone. Nearly 70 percent of the wells have been drilled in Allegan and Van Buren counties. These two counties contain more than two-thirds of the Traverse limestone oil pools so far discovered in the district. Fewer than 175 wells have penetrated Silurian or older rocks. More than 55 percent of these are credited to recent Salina pool development and the interest in Silurian exploration following development of the Overisel Salina gas pool in Allegan County. Except for several local areas (the Overisel, Salem and Dorr fields), Silurian rocks are virtually unexplored in southwest Michigan.

* Data cited were obtained from well records and reports on file with the Geological Survey Division, Michigan Department of Conservation, Lansing, Michigan.

In Southwest Michigan . . .

Silurian rocks have oil and gas potential

The Salina formation contains three possible oil and gas producing units involving several hundred feet of sediments

By Garland D. Ells, Assistant Petroleum Geologist,
Michigan Dept. of Conservation, Geological Survey Division
Lansing, Mich.

ALTHOUGH ORDOVICIAN Trenton-Black River formations are currently the "hot" drilling objectives in southern Michigan, the Silurian rocks of the southwestern district are receiving increased attention. Basal units of the Salina formation are a new target for exploration.

No extensive attempt has been made in the past to explore and develop Salina oil and gas resources in Southwestern Michigan. The discovery and successful development of Salina gas and oil pays in the Overisel, Salem and Dorr fields, Allegan County, was important for three reasons:

1. Development of the pools is an indication of the Salina oil and gas potential of the district.

2. Significant new knowledge has been added to the structural relationship of Devonian and Upper Silurian rocks for a limited area of the region.

3. Salina pool development and exploratory drilling has added new knowledge of the structural and stratigraphic aspects of basal Upper Silurian units and the underlying Middle Silurian Guelph-Lockport.

Significant Salina developments in Southwest Michigan began about two years ago. Most Salina oil and gas pools so far discovered are clustered in the north central townships of Allegan County. Future oil and gas prospects can best be indicated by consideration of the regional geology of the Devonian and Silurian rocks and by evaluation of stratigraphy and structure of known Salina pools.

Salina oil and gas production so far has been obtained from Silurian strata beneath or on the flanks of known Devonian Traverse limestone structures. Stratigraphy of Devonian and Mississippian systems is important, and may prove useful in future Silurian exploration in this region as well as other parts of the Michigan Basin.

Except for a few small, scattered rock outcrops, the district is covered with Pleistocene glacial drift of varying thickness and composition. Drift fills and covers the shallow valleys and channels of the eroded bedrock surface.

Figure 2 is a diagramatic section from Kent County southwest into Berrien County. This figure indicates the general stratigraphy of the region.

Bass Island-Salina rocks in Southwest Michigan. In the subsurface, Bass Island-Salina rocks are identified by lithological characteristics and

stratigraphic position. They have been divided into eight units (A through H) which may be traced over most of the Michigan Basin.[5] The A units are oldest and are the lower part of the Salina formation. The H unit is youngest and is equivalent to the Bass Island dolomite. Figure 3 shows the terminology currently applied to Bass Island-Salina formations in the subsurface.

An angular unconformity of low gradient cuts across Bass Island-Salina rocks. Southward from Kent County through Cass and into Berrien County, Devonian strata overlie successively older and lower Salina units. Figure 2 illustrates the general nature of the unconformity separating the Devonian and Silurian systems over a large part of Southwest Michigan.

Rocks below the Devonian strata have been mapped as Bass Island in age.[5] Recent subsurface studies have shown that some rocks previously referred to as Bass Island actually are rock units of the Salina formation.[6] The Bass Island is believed to have been eroded to a thin unit or completely removed over a large area. In some places, Devonian strata overlie different rock units of the Salina formation because of different levels of erosion into Bass Island-Salina rocks.

The A units comprise the important oil and gas producing zones of the Salina. In discussing these units, it is necessary to relate them to certain evaporite units within the Salina.

In the northern part of the district, as well as in the Basin proper, a thick salt bed (A-2 salt) occurs between the A-2 and A-1 dolomite. Over a part of this district a thick salt bed (B salt) occurs at the top of the A-2 dolomite. Another thick salt bed (A-1 salt) occurs at the base of the A-1 dolomite. From the northern part of the district southward, the salt units pinch out and the various carbonate beds are sometimes difficult to identify. The salt units have not been encountered south of Barry and central Allegan Counties.

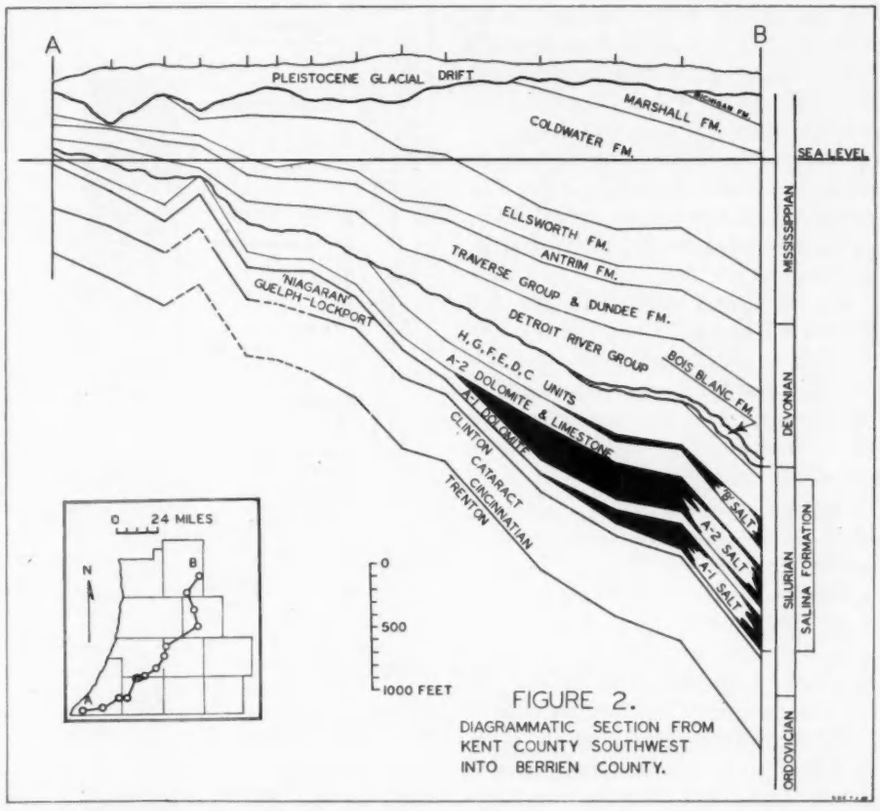


FIGURE 2.
DIAGRAMMATIC SECTION FROM KENT COUNTY SOUTHWEST INTO BERRIEN COUNTY.

FIGURE 2—Rocks below the glacial drift are almost entirely marine Paleozoic and range in age from possible Permo-Carboniferous to Lower Mississippian. Pre-Pleistocene erosion and some Pleistocene glacial scouring has removed a considerable section of sediments from a large area. In northeastern Kent County, sandstones, shales, and gypsiferous shales of Permo-Carboniferous and Pennsylvanian rocks are found directly below the drift. Southwestward from this point successively older and stratigraphically lower Mississippian rock units are encountered beneath the glacial drift. In southwest Berrien County, rocks of Mississippian-Devonian age are found below the drift.

Mississippian sediments are principally shales and silty shales with very subordinate dolomite and limestone members. Certain Mississippian formations thin from the Basin district outward toward the rim, but the thinning of the total Mississippian section is due largely to Pre-Pleistocene erosion.

Devonian rocks primarily are limestones, cherty limestones, dolomites and thin anhydrite beds. Some shale and shaly limestones occur in the upper part of the Devonian section in the Traverse Group. Rocks of the lower part of the Devonian section are mainly dolomites and thin anhydrite beds with thin sandstone and sandy dolomite beds of irregular distribution at the base.

Devonian formations thin progressively from the Central Basin district outward toward the edges of the Michigan Basin. In the deeper part of the Basin, the total thickness of Devonian sediments exceeds 3,000 feet. When traced southwestward from the deeper part of the basin up the regional dip, the total Devonian section thins to less than 300 feet in Berrien County. Thinning is due to lesser deposition of shales and carbonates; non-deposition of salt and a lesser amount of anhydrite in the Detroit River Group; and to erosional unconformities within the Devonian System.

Erosional unconformities are believed to occur at the top of the Traverse limestone in the Traverse Group;[1] at the top of the Dundee formation;[2] the Lucas and Amherstberg formations of the Detroit River Group;[3] and at the top of the Bois Blanc and Garden Island formations.[4] The Devonian rocks unconformably overlie Bass Island-Salina rocks of Upper Silurian age.[5]

Rocks of Upper Silurian age are believed to everywhere underlie Devonian formations in this district. The youngest rocks of the Silurian System in the Michigan Basin are those of the Bass Island-Salina formations. The uppermost unit (Bass Island) is a dense dolomite sequence. It conformably overlies the evaporite bearing Salina formation. In the deeper part of the Basin, Bass Island-Salina rocks exceed 3,400 feet in thickness. Much of the thickness is due to salt beds in the Salina formation. When traced from the Basin district into southwest Berrien County, Bass Island-Salina rocks thin to little more than 100 feet. The great amount of thinning it due largely to non-deposition of Salina salt beds over most of the district, and to several periods of erosion following the deposition of the Bass Island dolomite.[5, 6]

Uppermost oil and gas producing zone. The uppermost pay section of the Salina is in the "E" zone. Sometimes referred to as the "Kintigh Zone," this section is generally porous and has frequently carried shows of oil and gas. However, only one oil well has been completed in this zone. The oil and gas potential of this section cannot at present be properly evaluated.

The A-2 dolomite is a more prominent gas, and possible oil, producing unit. It is a fine grained to crystalline dolomite which (in the area of salt deposition) may contain some limestone. Outside the area of salt deposition, the A-2 appears to be entirely a dolomite. The A-2 dolomite may contain some anhydrite lenses which pos-

sibly act as cap rock. The unit is as much as 200 feet thick and contains porous zones at different intervals. The buff to brown A-2 dolomite conformably overlies the gray, shaly and argillaceous A-2 limestone. Outside the area of salt deposition, the A-2 limestone unit appears as a gray, shaly, argillaceous dolomite, rather than limestone.

The A-2 salt underlies the A-2 limestone. Some wells have penetrated as much as 385 feet of A-2 salt. This salt unit pinches out southward, but the horizon may be represented by thin anhydrite beds which can be traced for some distance.

The A-1 dolomite (up to 130 feet thick) is the lower oil and gas producing unit of the Salina. It is a dark colored carbonate, shaly in some areas. The unit differs in character vertically and laterally. It is mainly dark brown or almost black in color and ranges from a sublithographic to finely crystalline limestone or dolomite. Southward (away from the area of salt deposition), the A-1 unit becomes lighter in color and more homogenous in lithology. Outside the area of salt deposition, it is entirely a dolomite. The A-1 dolomite is underlain by the basal evaporite unit of the Salina.

The A-1 evaporite is a salt bed as much as 200 feet thick in the northern counties. The A-1 salt has the greatest lateral extent but also pinches out to the south and southwest. The horizon may be represented by thin anhydrite beds which can be traced for some distance. In much of Southwest Michigan, the A-1 salt is underlain by a buff to brown, crystalline dolomite or limestone referred to as "Brown Niagaran" or Guelph. Where the A-1 evaporite is not present, the A-1 dolomite lies upon the Brown Niagaran.

The "Brown Niagaran" seems to have affinities with the Salina formation and is classified as the basal member of the Salina formation. Some geologists consider this unit to be the top of the Middle Silurian Niagaran Group. The "Brown Niagaran" has not produced oil or gas in this district, but in Southeastern Michigan (St. Clair County) it is a prominent producing unit.

Structural features of Devonian and Silurian rocks. Comparatively few wells have been drilled into or through the Silurian rocks of Southwest Michigan. There is some indication of regional structural trends on the surface of the eroded Upper Silurian rocks, but little is known about smaller structures that are potential gas and oil traps. The structural aspects of recent Salina oil and gas pools are known. However, too few Salina pools have been developed to indicate how local Salina structure is related to regional Bass Island-Salina structural trends.

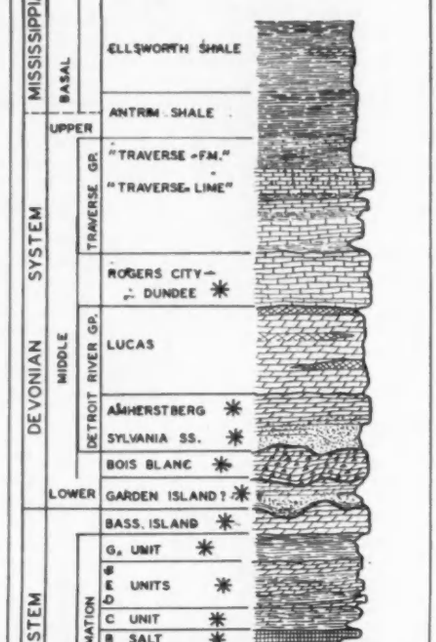


FIGURE 3—Here is a chart of the Upper Silurian and Devonian formations of southwest Michigan. The terminology used is currently applied to Bass Island-Salina formations in the subsurface.

To date, Salina oil and gas pools are associated with Devonian Traverse limestone structures. This is true of the Overisel, Dorr and the Salem, Salina pools.

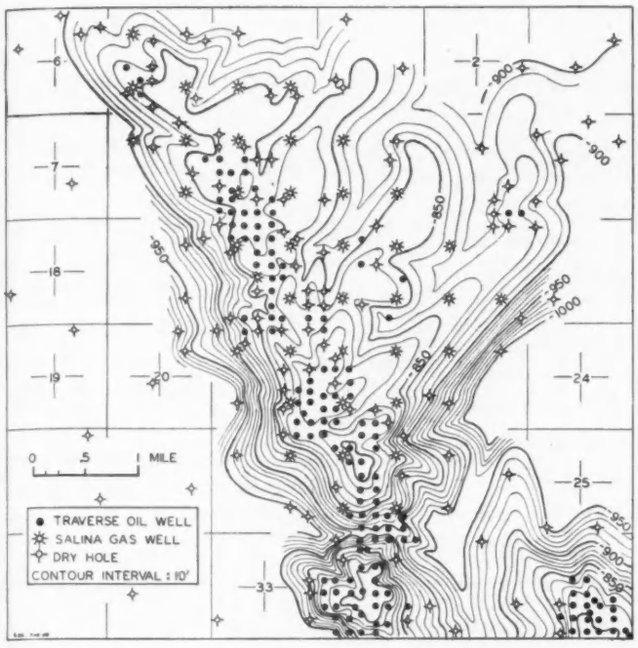
Regionally, much of Southwest Michigan may be classified as a platform or shelf area associated with the Kankakee Arch and, perhaps, Pre-Ordovician regional structure. Mississippian, Devonian and Upper Silurian rocks thin from the central basin southward and over this region. Average regional dip basinward on the surface of the Traverse limestone, is about 17 feet per mile. Major regional structural trends on this surface appear to plunge northeast or basinward. It is on these larger trends that the smaller Traverse limestone oil producing closures occur.

In general, most of the Traverse producing closures have a NW-SE or a NE-SW lineation, but some are E-W. Many of the smaller structures are more or less circular in plan. Relatively narrow synclinal troughs or closed depressions separate the producing closures and regional trends.

Most Salina pools in Southwest Michigan are located in the central six townships in the north one-half of Allegan County. One pool is located in Ottawa County, and earlier this year a Salina gas discovery was made in northeastern Calhoun County. The gas appears to be from the A-1 dolomite section. Structural features on the surface of the Traverse limestone are similar to those described previously. On the larger Traverse structures, relief from the highest well in a field to the lowest dry hole in the synclinal troughs flanking the field may be as much as 175 feet. The structural relationship of the Devonian Traverse limestone and the surface of the Upper Silurian A-2 dolomite unit are best known in the Overisel Field (Figures 4 and 5). Similarity of structure on the Traverse limestone and the A-2 dolomite unit is apparent in the Dorr Field and Salem Field which is currently being developed.

Reef development indicated. Niagaran reef development over a large part of this region may have bearing on some Salina structure.[6] Reef development in upper Middle Silurian rocks is indicated where these rocks outcrop at various places on the edges of the Michigan Basin. Salina oil and gas fields in St. Clair County are believed to be associated with Niagaran reefs.

To the east of St. Clair County, in Ontario, Canada, reef bearing Guelph-Lockport rocks are said to project upward into Salina rocks as much as 400 feet.[7] Reef build-ups in Guelph-Lockport rocks have had affect upon the Salina producing units in St. Clair County and in Ontario, Canada. The lower evaporite units (A-2 and A-1) often pinch out or



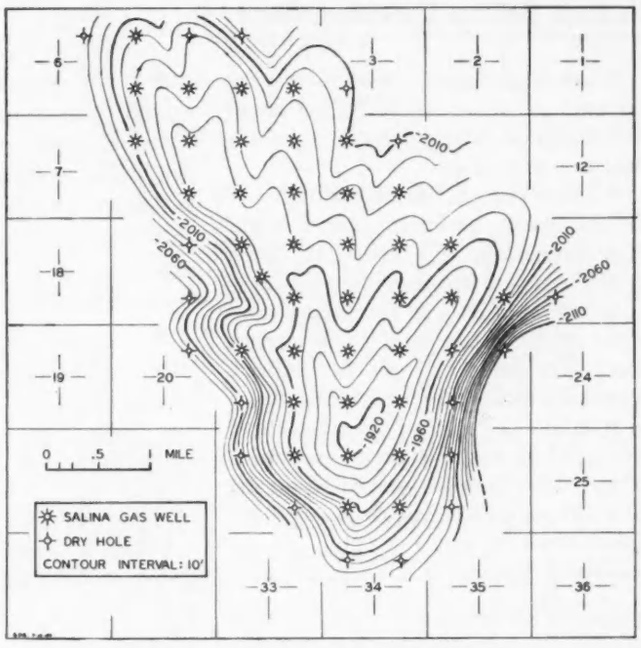


FIGURE 4 (left) and FIGURE 5 (right)—The similarity of the Overisel field structure on the surface of the Traverse limestone and the A-2 dolomite is illustrated by these contour maps. Marker beds in Mississippian rocks above the Traverse limestone often conform to Traverse structure. Contours on the top of the Detroit River anhydrite bed, below the Traverse Group, conform to structure of the Salina A-2 dolomite. The thickness intervals between the top of the Traverse limestone and the top of the A-2 dolomite is slightly more than 800 feet. Well records show some indication of slight thickening of sediments between the two horizons off structure; but there is little evidence of axial shift between structure on the A-2 dolomite. The highest closure on the A-2 dolomite appears to be directly below the highest closure on the Traverse limestone. However, the oil producing closure of the Traverse limestone is limited to a smaller part of the total structure than the closure of the Saline A-2 gas pay.

thin against the reefs. Most reefs in St. Clair County are believed to be of the pinnacle type. Similar conditions of lesser magnitude are believed to occur in parts of Southwest Michigan.[6]

Some wells in Southwest Michigan have penetrated as much as 175 feet of A-1 salt, when nearby wells have encountered none. In some wells having no A-1 salt, the Guelph-Lockport ("Niagaran") and the A-1 dolomite have been structurally high in relation to control wells, and the units above the A-1 dolomite appear structurally conformable.

In some areas, the Niagaran, or Guelph-Lockport, appears to be flanked on the north and south by the A-1 salt bed. These "projections" of Guelph-Lockport are believed to be reef type build-ups that have had some influence on structure in the basal units of the Salina.[6]

Insufficient data are available in a small confined area to substantiate whether the Guelph-Lockport thickens or thins locally due to reefing. Most wells are bottomed out without drilling completely through the Niagaran section.

Structural closure in the Salina A-1 and A-2 dolomites also may be due to thickening of the basal Salina A-1 salt bed in local areas. In effect, these structural features are small salt domes or "salt swells" of the non-piercement type. The amount of structural relief in the A-1 and A-2 dolomite beds due to salt doming has been limited because of the relatively thin basal salt bed in this region. Thickness of A-1 salt has varied from zero to as much as 186 feet in Allegan County.

Recent drilling to the Silurian Salina producing sections beneath Devonian Traverse limestone structures tends to support the view that some structural features are due to readjustment of the basal Salina A-1 salt bed. As much as 150 feet of salt has been penetrated in wells that were structurally high on the Devonian Traverse limestone and on the Silurian A-2 dolomite. Wells on the flanks of the same structural feature have been structurally low on the top of the A-2 dolomite and no salt was encountered. These wells, of course, were drilled completely through the Salina into the Niagaran. Salt doming, and perhaps reef build-up, may account for Salina structure in the Overisel, Salem, Dorr and West Hopkins Fields, since these Salina pools appear to have unique salt-structural features.

Salina oil and gas pools. At the end of 1958, there were six Salina oil and gas pools in Southwest Michigan. Development has lagged in the more recently discovered pools and little can be said in regard to them. Complete production and reservoir data are not available for all Salina fields. General field, production and some reservoir data are given for the larger and more developed pools.

• **Salem field.** The Salina pool in this field appears to be related to Traverse limestone structure. The Salem Traverse limestone pool was discovered in 1937, and covers an area of 3,390 acres. Salina gas has been produced from one well since 1937. Production is from the A-2 dolomite, at a depth of 2,725 feet. Cumulative production from this single well was nearly 324 MMcf at the end of 1957. Bottom-hole pressure at the time the well was completed was reported to 1,150 psi. Gas and shows of black oil were reported in the deeper A-1 dolomite, but were plugged off and production was obtained from the A-2 dolomite.

A second well was drilled and completed in 1957 as a shut-in gas well. Follow-up drilling was begun in 1958. By mid 1959, 30 gas wells and 26 observation wells had been completed. The gas wells are spaced one well to

Future Salina Development

From a geological view point, the oil and gas potential of Salina rocks in Southwest Michigan can be summarized as follows:

- More than 6,700 square miles of Salina rocks underlie this district. Not more than 175 wells have been drilled into or through the pay horizons of the Salina formation and most of these are field development wells. The district is wildcat territory as far as the Salina is concerned.
- Salina formation contains three potential oil and gas producing units. These units involve several hundred feet of sediments which are potentially productive.
- Salina production has been obtained beneath known producing Traverse limestone structures. There are many Traverse limestone structures, local and regional, throughout this district. Silurian formations beneath the great majority never have been penetrated.
- Niagaran reefs, or Salina structure due to Niagaran reefing, are potential oil and gas traps. Structure due to salt doming or salt readjustment also is a possibility.
- Stratigraphic and porosity traps within the Salina are a possibility.
- The unconformity at the top of the Silurian system is a potential zone for oil and gas entrapment. Numerous shows of gas have been encountered at this horizon.

Another point of interest concerns the possibility of converting Salina gas pools to storage fields. Southwestern Michigan is in a favorable geographic position in relation to Northern Indiana and Northeastern Illinois industrial centers. Silurian gas pools, if large enough, and if reservoir conditions are satisfactory, have possibilities as underground gas storage reservoirs.

a quarter section and the field is considered to encompass nearly 5,000 acres. Total gas reserves are calculated to be nearly 72 billion cubic feet. Net pay within the field ranges from 3 to 45 feet; net porosity from 6 to nearly 13 percent, and average permeability from 0.55 to 7.97 Md.

- **Dorr field.** The Salina gas and oil pool in this field also is associated with Traverse limestone structure. The Dorr Traverse limestone pool was discovered in 1938, and covers an area of 400 acres. A small amount of heavy, black, 22-gravity oil was produced from the A-1 dolomite in 1942. The well was abandoned in 1943, and no further attempt was made to develop the Salina pays until 1956. Production again was obtained from the A-1 dolomite; however, the bulk of present production is obtained from the A-2 dolomite.

Gas-oil ratios of individual wells vary considerably. Some brine is produced with the oil which is obtained by pumping and natural flow. Salina pool development has been slow.

- **Overisel field.** The Overisel Salina gas pool also is associated with Traverse limestone structure. The Traverse oil pool was discovered in 1938 and covers 1,770 acres. The Salina A-2 dolomite pool was discovered in 1956. By the end of 1957, 38 gas wells had been completed in the field. The productive Salina area covers more than 6,000 acres. Approximately 25 feet of lensed pay has been recorded in the A-2 dolomite at a depth of about 2,650 feet.

The A-2 dolomite pay in this field is comparatively tight. Permeability factors from a number of samples from different wells in the field range from 0.9 Md. to 14.0 Md.; porosity ranged from 5.8 percent to 18.6 percent; and wetting phase saturation at 1,000 psia ranged from 4.9 percent to as high as 25.4 percent. Some water is produced with the gas. Gas reserves are reported to be in excess of 60 billion cubic feet. The field was sold and eventually will be converted to a gas storage reservoir. No gas was produced from this field until 1958. Several wells were drilled around the margins of the pool in 1958. The wells were classified as observation wells and completed as dry holes. Nearly 50 facility wells are scheduled to be drilled in this field. The deeper A-1 dolomite unit has not been explored adequately and little is known of its potential.

Future Salina development. Most wildcat drilling into or through the Salina rocks of Southwest Michigan has been sporadic or incidental to Trenton exploration. Development of the Overisel, Dorr, and Salem pools has been viewed with interest by both major and independent companies. Although one company[8] reported 75,000 acres under lease in the Allegan area at the close of 1957, Salina exploration has not been exceptionally rapid. The Salina formation in this district is virtual wildcat territory, and most exploratory tests have been made close to known Salina pools. Companies seem reluctant to "step-out" until more knowledge of the structural and reservoir conditions of Salina rocks is available.

About the Author

Garland D. Ells received a B.S. degree in geology from Michigan State University in 1952. Upon graduation, he joined the Michigan Geological Survey as a petroleum technician and spent about two years in the regulatory branch of the oil and gas section in the Basin district field office. After transferring to the main office in Lansing, he became engaged in sample study and related work. In September, 1955, he was promoted to assistant petroleum geologist in the Petroleum Geology section. Assistant petroleum geologist is his present classification.

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How to produce high pour point, waxy crude

FIGURE 1—This mass of paraffin was removed from a plugged flowline at Red Wash. The various preventative techniques now applied prevent such accumulations.

Correct application of downhole heat, scrapers minimizes paraffin accumulation in the wellbore. Electric heating cables, line heaters prevent plugging of surface equipment

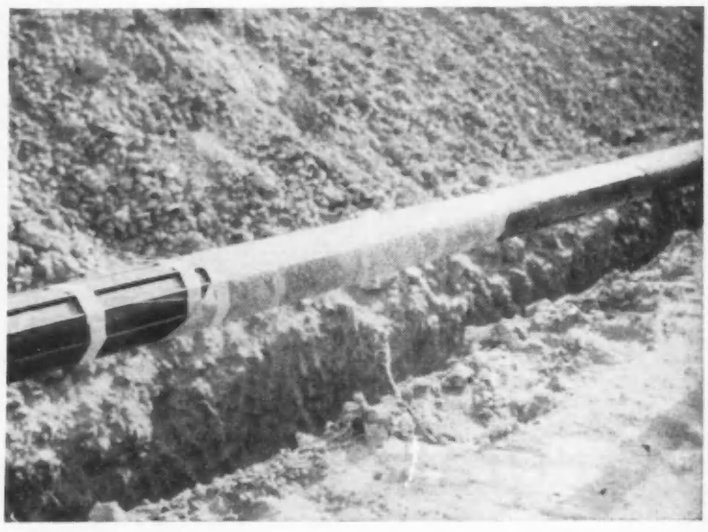

FIGURE 2—Here is the proper way to apply electric heating cable to flowlines. From left to right, the cable first is attached to the pipe with paper masking tape. Next, a glass fiber coating is installed and pipe dope is applied. Finally, the job is completed by wrapping the line with a 15-pound felt protective coat.

By J. J. Dremer
General Engineer
Standard Oil Company of California
Vernal, Utah

THE DIFFICULT problem of producing high pour point (95° F), waxy crude under adverse temperature conditions has been solved by Standard Oil Company of California. In Red Wash field, Utah, SOCAL has successfully applied the following measures to prevent paraffin plugging of wells, surface lines and producing equipment:

- Bottom-hole heaters
- Paraffin scrapers used in conjunction with rod rotation
- Hot oil treatments
- Steam phase line heaters
- Electric heating cables.

These techniques should be readily applicable to other areas faced with similar producing problems.

Red Wash is located about 25 miles southeast of Vernal, Utah. It is 5,700 feet above sea level and the ambient temperature varies between —40° F and +100° F. Discovered in 1951, the field produces a waxy 28 gravity crude with an average pour point of 95° F. Bottom-hole temperature is 125° F and wellhead temperature varies between 60° F and 70° F depending on the season. Producing formation is the Green River sandstone and average depth is 5,500-6,000 feet.

Originally, production was handled unsuccsessfully in the same manner as higher gravity, lower pour point oils. Wells paraffined up in the tubing, flowlines plugged solid and other facilities failed due to plugging. It soon became evident that new methods would have to be developed to move the crude to market. Heat in large quantities was needed to keep the oil at a temperature above its pour point during its progress from well to refinery.

Tanks, separators, treaters and other fixed pieces of equipment could readily be heated either with direct fired burners or by using steam from low pressure boilers. Flowlines presented another problem not so easily solved. The field luckily produces sufficient natural gas to provide a plentiful source of fuel for heating.

The first wells were produced to individual tank batteries located at the well site and the oil trucked out of the field to Rangely, Colo. As development progressed, it became evident that the areal extent of the field would

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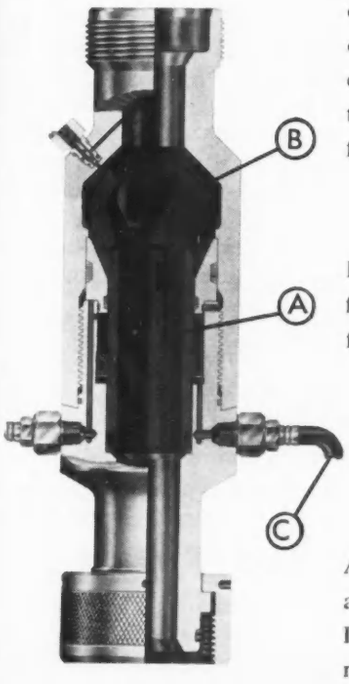

Fig. 1
Open Position

TO CLOSE (Fig. 1)

Pressure applied at Inlet (C) drives Piston (A) upward, forcing the three Rubber Covered Metal Segments (B) to form a solid, pressure tight "cone" – (Fig. 2). This closure will effect a seal around the wire line. When tools and line are out of the hole, the Segments seal tightly, completely shutting in well pressures.

TO OPEN (Fig. 2)

After opening the Equalizer Valve (E) to balance pressures above and below Segments, hydraulic pressure is applied at Inlet (D) driving the Piston (A) downward, drawing the Segments also down and outward into the recess area provided for them. This returns the tool to its full open position.

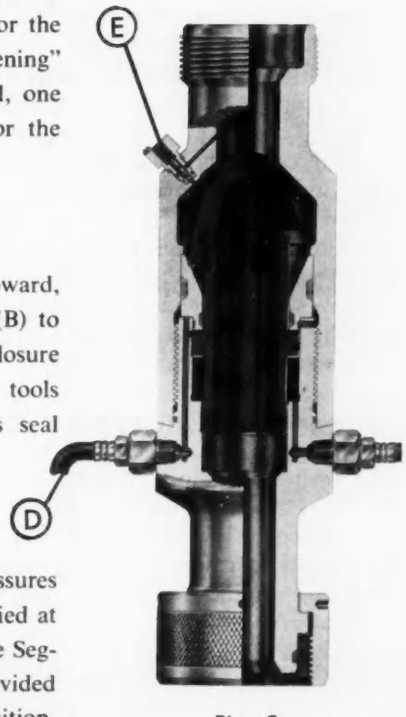

Fig. 2
Closed Position

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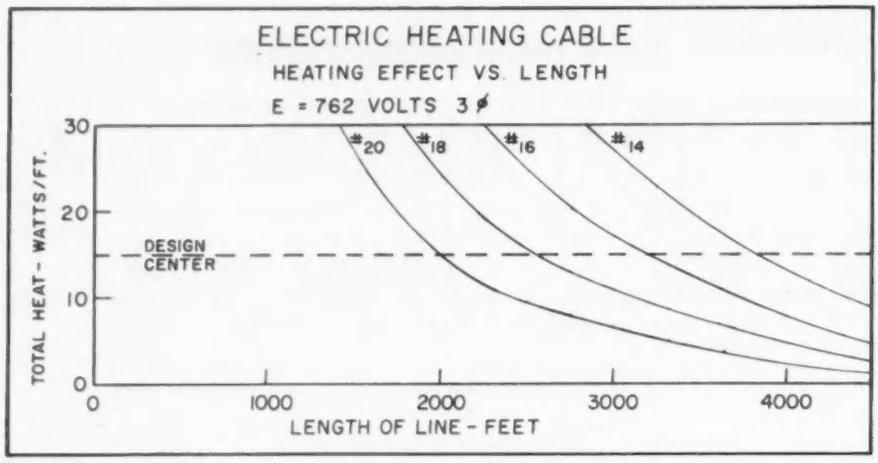

FIGURE 3—Data from these curves are used to determine the correct size wire for the job when equipping a flowline with electric heating cable.

be quite large and studies were initiated to provide a centralized gathering system where the crude could be processed and delivered to a pipe line in the normal manner.

Production. Pumping high pour point crude presents specialized problems. Wellhead temperature is considerably below the average pour point. Crossover at the 95° F pour point temperature occurs at a depth of approximately 3,500 feet. In most wells paraffin deposition will start at this point and become increasingly heavier toward the surface. In isolated cases, paraffin will deposit from the bottom of the well to the surface. These are more or less problem wells and must be dealt with on an individual basis since scrapers will not help the situation.

Normally, paraffin scrapers are run on the upper 3,500 feet of sucker rods. The vertical paddle type scraper used with rod rotation has been found to be the most successful, since it presents a small cross-sectional area which does not normally become clogged with paraffin.

In those wells where full depth deposition is a problem, it is necessary to install some form of bottom-hole heater. At present only two wells at Red Wash are equipped with bottom-hole heating equipment. A hot water circulating system is used in which the heat exchanger is located below the pump seating nipple. A small hot-shot boiler and an electric circulating pump located at the surface provide the source of heat.

This method is available commercially and has been used successfully on 3,500-foot production in California fields and is used at Red Wash at a depth of approximately 6,000 feet. Although a good degree of heating is attained, there are some problems. A closed system is used and the input and return lines are clamped to the production tubing string. Movement of the tubing has caused collar leaks in the hot water string. Originally, a 1-inch pipe string was used. However, structural strength was insufficient. A 1¼-inch tubing string was substituted with good results.

Hot water input temperature is about 300° F and the return stream is 150° F, the same temperature as oil at the wellhead.

The use of bottom-hole heat does not increase ultimate recovery except in that the average daily rate is higher on a long term basis due to the elimination of downtime caused by stuck rods and pulling jobs. A 10 to 20 bopd increase has been noted in the two wells using bottom-hole heat.

Bridging in the annulus caused by solidification of the oil at some intermediate point between top and bottom of the well also is a problem encountered at Red Wash. This is caused by a static fluid level in that part of the well bore above the crossover point of temperature. There appears no solution for this situation except to keep the well producing at a rate that will insure a low fluid level. If a bridge occurs, hot Rangely crude is pumped down the annulus to melt out the plug. Field equipment used for this purpose is skid-mounted and highly portable, so jobs can be completed in a relatively short time.

Flowline design and heating. In the early days of development, various methods were used to heat well flowlines. One of the earliest was the steam trace in which a parallel line was installed along with the oil line. Both lines were buried to a depth of 5 feet to minimize frost effect and reach a point at some more or less uniform ground temperature. This method depended almost entirely on both lines remaining in close proximity. After a short time the expansion and contraction of the steam line caused it to move away from the oil line and the separation resulted in failure to heat. Line breaks also occurred and sags in the line filled with condensed fluid. The 10 psig steam could not be used to displace these plugs from a long line. This method now is limited only to short lines.

Electrification of the field in 1953 generated interest in the use of electric heating cable applied directly to the flowline. The first concept of electric heating was to apply all the heat needed and eliminate other methods of heating. This concept has since been disproved and the electric heating cable is now used only as a supplementary means of breaking plugs which occur when the line is shut down or when malfunction of equipment results in plug formation.

Lead covered heating cable first was used. Field testing and collaboration with various wire manufacturers has since resulted in a superior product using PVC insulation.

Electric heating cables can be used to extend the period between line plugoffs but they are not a substitute for gas fired line heaters. Extended use of electric heating cables will result in their early failure. During use, paraffin will start to deposit in a layer on the inner surface of the pipe. As this inner ring increases in thickness, it acts as insulation between the small quantity of heat provided by the cable and the flowing stream of oil. The back pressure buildup at the wellhead proves this statement and unless remedial action is taken, a solidly plugged line will result.

In this case the heating cable will

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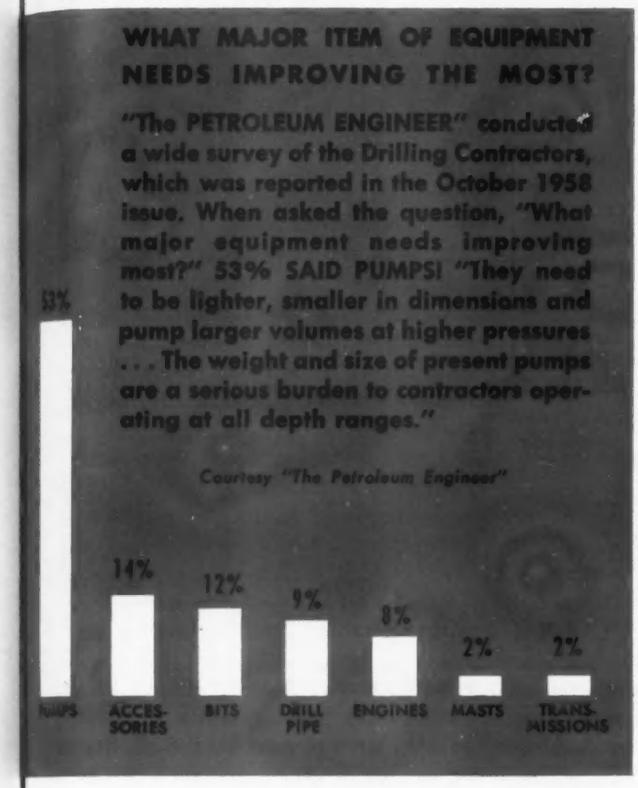
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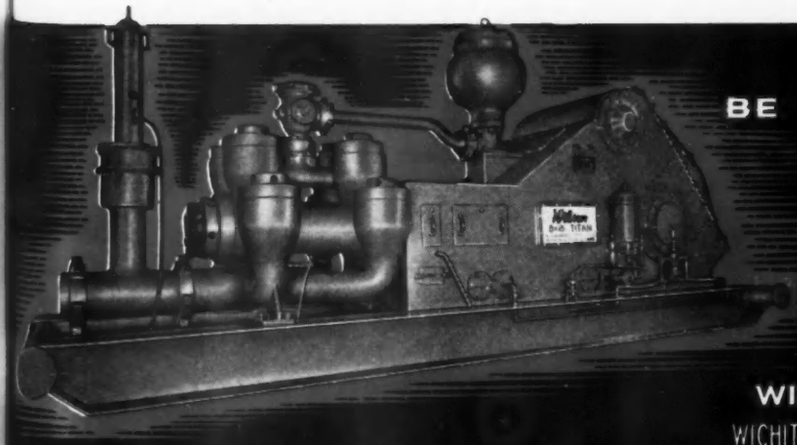

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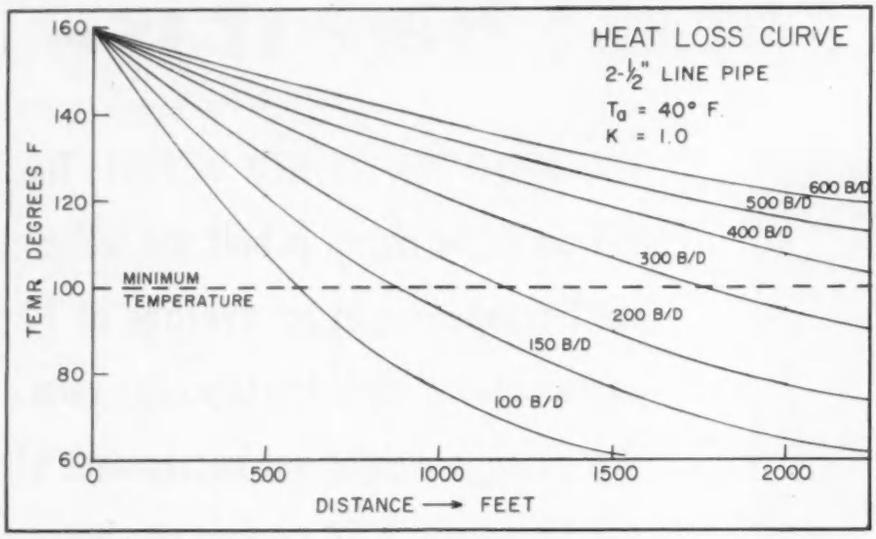

FIGURE 4—This set of curves is very useful in spacing line heaters at correct intervals. Heater spacing is controlled by the distance required for the initial temperature to drop to 100° F, the minimum safe operating crude temperature.

not help in freeing the line since the core of paraffin next to the pipe wall has, in effect, been squeezed free of oil and will not melt without the use of an acetylene torch flame. In such cases, the only resort is to dig up and replace the line with new pipe. The old line can only be freed of the paraffin plug by stacking and burning out the plug (Figure 1).

The correct use of electric heating cables as developed at Red Wash is not as a prime heating source but as a secondary one only. If heat is applied to the pipe with the heating cable for a period of approximately four to six hours before pressure is applied at the wellhead, a film of melted oil is generated around the pipe wall. This allows a plug to move through to the next line heater and be converted into a fluid state. It must be emphasized that no attempt should be made to unplug the pipe by application of high pressures before the initial heating period. Pressure applied too early has the effect of squeezing the oil from the plug and no reasonable amount of heat will free a flowline plugged with paraffin alone.

Cable installation. Proper installation is most important to insure correct operation of heating cables. They must not be stretched, crossed or abused. Cables are installed on the pipe after priming and held on temporarily by paper masking tape. Eight wires spaced equally around the circumference of the pipe are used. After cables are secured, a layer of glass fiber is installed. A flood coat of pipe line dope then is applied and 15-pound asphalt-impregnated felt wrapped around the entire unit for protection (Figure 2). Care is taken to keep the temperature of the dope low enough so as to not injure the PVC insulation on the heating cable.

The wire is run longitudinally and not spiraled for a very good reason: if a fault appears at a later date the exact trouble spot can be determined by using a Wheatstone bridge. This system has been used successfully for a number of years.

A total of eight wires is run on each line. The heating circuit consists of three wires only. Heat is applied to one heating circuit and then to the second if more is needed. The remaining two wires are spares in the event of failure of any of the primary units. Heating circuits are designed to provide an average of 15 watts per foot for three wires or about five watts per foot for each of the three wires in the circuit. Flowline length determines the size of the wire used since each is limited in the length which will fall within the restriction of 15 watts per foot. Sizes normally used are AWG 16, 18 and 20. If a longer line is encountered, two circuits using combinations of the above sizes are used. In short lines, No. 19 wire with PVC insulation has been used quite successfully.

Figure 3 shows the relation between length and power dissipation per foot for three wires of the different sizes commonly used. Curves are based on the use of 762 volts.

Ditch preparation. This is an important part of heating cable installation. Some earlier lines were installed without protecting the cables. Backfill was placed indiscriminately and rocks caused considerable damage to the heating cables. Currently, the bottom of the ditch is padded with clean rock-free material to a depth of one foot before the line is installed. Belt slings are used and minimum contact with the ditch walls is maintained. During the entire lowering operation, care must be taken to keep loose rocks from falling into the ditch on top of the pipe and damaging the cables. After the line is in the ditch and centered, additional rock-free padding is placed to cover the pipe to a depth of two feet. Only then is regular backfill placed in the normal manner.

These precautions may seem unnecessary but experience has shown them to be required to insure long heating cable life. The rock-free padding protects the pipe line from the rough backfill and allows it to move freely without danger from abrasion.

Heaters. As mentioned previously, the electric heating cable is not the prime source of heat for the oil. Steam phase line heaters are used to keep the crude at a temperature above 100° F at all times. Their design involves only a knowledge of heat transfer and heating requirements.

Heater spacing is governed by heat loss to the earth. Figure 4 shows the relationship between heat loss, volume of fluid and length of line for an initial temperature of 160° F and a 2½-inch flowline buried five feet. Heater spacing is controlled by the distance required for the initial temperature to drop to 100° F. This is the lowest safe point to which the crude can be allowed to drop before additional heat is introduced. Some allowances are required in placement of the units due to terrain difficulties and other factors governing each individual flowline.

The settled production rate is used in sizing heating requirements so that during flush production periods, the heating capacity may be excessive. This is handled by running intermediate units as water bath types where a lower heat transfer rate can be maintained until the higher rates are needed.

Line tracing. As indicated previously, electric heating cable tracing is not

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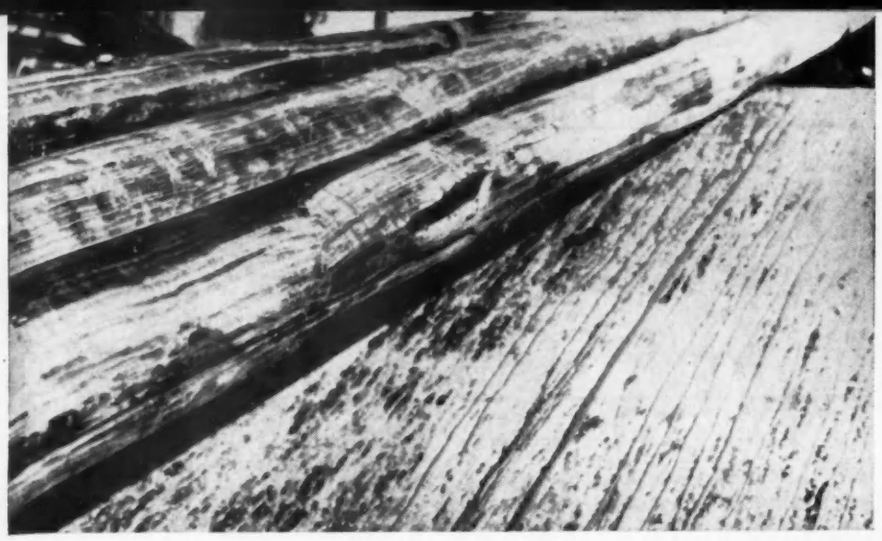

FIGURE 1—The split in this pipe which measured 18 inches represents a ductile type failure. This failure probably started with a pin hole and washed out to its present size.

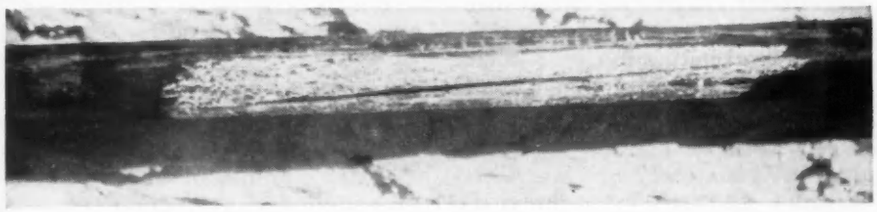

FIGURE 2—A burst failure along a seam. Seams are universal even in seamless casing where the seam is formed by drawing out gas and slug pockets.

Casing failures

- Types
- Cures
- Detection
- Prevention

By Larry C. M. Darling
President and General Mgr.
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Alberta, Canada

CASING FAILURES result primarily from stress cracks, flaws in forging, rolled-in blisters, piping, sand and slag inclusion. Root defects and poor bonding of welds are flaws which may be found in welded casing. Under load, the edge areas of the defects are subjected to stress peaks which can lead to crack propagation and, finally, to complete rupture (Figures 1 and 1-A).

CAUSES

Casing failures are considered to be caused by three primary forces: bursting, collapse and tension.

Considered as secondary causes are crushing, wear, erosion, buckling, torsion, leakage, shock and surge, transportation and handling, miscellaneous (welding, perforating, hydraulic fracturing, acidizing), mechanical due to workovers, and corrosion.

Primary causes

Bursting—A burst failure is usually a longitudinal split measuring from one to 6 feet in length (Figure 2). They may be caused by the following:

- Excess ductility on a portion of the joint, or vice versa.
- Brittleness caused by improper heat treatment.
- Internal plug scores caused by bits of sharp metal sticking to the high mill plug immediately after the piercing operation.
- Seam failures: Seams are universal even in seamless casing where the seam is formed by drawing out gas and slag pockets.
- "Overfill" or "fin" which has been rolled and pressed to the outside surface, essentially giving a thinner wall on the tube.
- Dinging, and tong marking. The combination of flattening and notching reduces burst pressures as much as 70 percent with notch depth.

Collapse—A true collapse will flatten a length of casing from wall to wall. The prime reasons for collapse are:

- Earthquake or faulting.
- Squeeze job collapse.
- Denting—A dent or dinge is the most harmful accident that can happen to a joint or casing. A tube deformed only 1 percent out of round can have its collapse resistance lowered 25 percent.
- Crushing by slips and tongs.

There is no known satisfactory means of testing for collapse, but experience has shown that if a tube will stand an internal pressure of 80 percent of its yield strength, it will also withstand an external pressure greater than its published collapsed strength.

Tension—The single mill defect attributable to almost all tension failure is that of a hardened portion in the joint. This is caused by slippage in the rollers or accidental cooling with water.

Casing is usually designed to be run with a high safety factor in tension (average 1.8). This is because of the many variables affecting tension during its use. Some of these variables are mentioned as:

- Weight of the casing itself.
- Shock loads while running casing.
- Tight spots in the well bore when reciprocating.
- Reciprocation during cementing operation.
- Heating and cooling during production.
- High fluid pressures during treatment.

Compression failures, the opposite of tension failures are rare.

Secondary causes

1. **Crushing**—Slips and tongs are the major causes of this type of failure and extreme caution is the only remedy.

2. **Wear**—If drilling is done inside

the casing, the drill pipe should be protected with rubbers at the tool joints. A tubing anchor will stop tubing—against casing wear called "tubing breathing".

3. Erosion—The erosive action of a hydraulic fracturing treatment or an acid treatment could be a factor in contributing to casing failure.

4. Buckling—API joints are not designed to withstand bending stresses and will burst or fail at relatively low loads. The casing should be kept in tension from top to bottom at all times.

5. Torsion—If casing is rotated during cementing operations, there is a slight chance of a torsion type of failure. Rotation should be stopped if the casing starts to make up.

6. Leakage—Leakage can be in either direction, that is from inside out to a thief zone or conversely, from the outside into the well bore.

7. Shock and surge—Surge pressure during treatment or immediately after perforation will shock or vibrate the string. Failure can occur at weak points in the casing.

8. Transportation and handling — These causes are the biggest contributors to casing failure. Casing is hydrostatically tested to API specifications at the factory, and yet will still fail when it reaches its ultimate destination, that is, cemented and in the well bore. Considering the numerous loadings and unloadings, trucking and shuffling during transportation, tonging and tension stresses placed upon tubular goods before it reaches "in the hole" status, one is not too surprised at the high rate of casing failure. The only logical conclusion is that additional testing is necessary to augment factory inspection.

9. Miscellaneous:

• **Welding**—Failures have been attributed to welding imbrittlement. A precautionary measure is the use of pre-heating and slow cooling during the process. The use of the new high strength thread locking compounds having a higher break-out-torque than that for welding is strongly advocated.

• **Perforating**—There is little that can be done to protect casing from splitting during perforation other than to insure that the casing is completely surrounded by cement.

• **Hydraulic fracturing**—The advent of hydraulic fracturing with its large demands on casing performance is perhaps one of the greatest single factors contributing to casing failure. The additional costs of testing can be offset by the elimination of failure repair cost, by the use of smaller diameter casing, and also with closer attention paid to designing the string to minimum API tolerances.

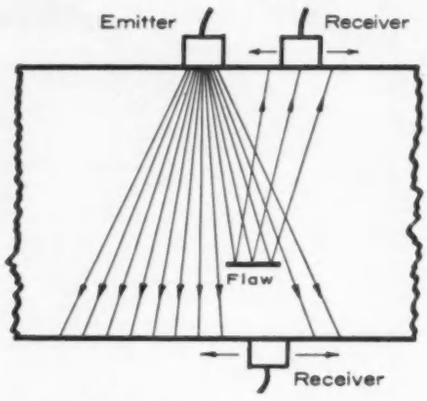

FIGURE 3—In the ultra-sonic wave analysis method of pipe testing, sound waves are deflected at a flaw and may show up either as a wave shadow or reflection.

• **Acidizing**—Acidizing pressures are increasing because of the increased depth of oil wells. The same remarks as pertaining to hydraulic fracturing above are applicable.

10. Mechanical—It is not possible to estimate the amount of damage done by mechanical means during workovers. Excess speed in running tubing, unwarranted surges, and plain carelessness are just a few of the possibilities.

11. Corrosion—Corrosion is the result of electro-chemical or chemical reaction between a metal and its surroundings. Anodes and cathodes can be formed on the metal because of local differences in the metal or in the environment, and erosion occurs at the anode. The local differences can be chemical or mechanical and are caused by: impurities such as oxides and other inclusions, grain boundaries, orientation of grains, differences in composition of the microstructure, localized stresses, and scratches and nicks.

Corrosion costs around $6 billion dollars per year in the United States and its control is a study in itself. The only specific mention to be made on this immense problem is that field testing of casing can eliminate some of the bad joints which probably would have contributed to a casing failure by corrosion.

DETECTIONS

It is possible that a casing failure will remain undetected for a long period of time, even to the point of not being noticed for the life-time of the well. A thief zone can absorb all or a portion of production through a casing failure and conversely, a high pressure water zone can mask all or a portion of the oil production through a casing failure. Some of the more obvious indications of failure are as follows:

- A decrease or loss in production.
- An influx of water or gas.
- Loss of casing and/or tubing pressures.
- Loss of pressure during workover treatment.
- Existing casing pressures when a packer is being used.
- A poor producer in a field of good producers.

It is apparent that most detections of casing failure are based on comparisons with nearby wells. This is an indication of the essentiality of being as confident in the casing as is humanly possible, when running long string on a wildcat well.

CURES

The mechanics of repairing a casing failure have advanced to a high level of technique. Predominant methods of repair, after determining the depth of the failure, are:

- Cement or plastic squeeze.
- Cut-off and replacing the bad joint.
- Patching with a fluid type seal.
- Setting a packer.
- Lining the casing.
- Directional drilling and resetting casing.
- Abandonment and redrilling.

The above methods can be extremely complicated and elaboration is not included in this article.

PREVENTIONS

A great deal of time and labor has gone into the prevention of casing failure. Some of the prime methods striving for elimination of casing failure are:

1. Visual inspection.
2. Hydrostatic pressure testing.
3. Magnetic powder method.
4. Magneto—inductive and electrical methods.
5. The penetration method.
6. Packer testing.
7. X-ray analysis.
8. Gamma-ray analysis.

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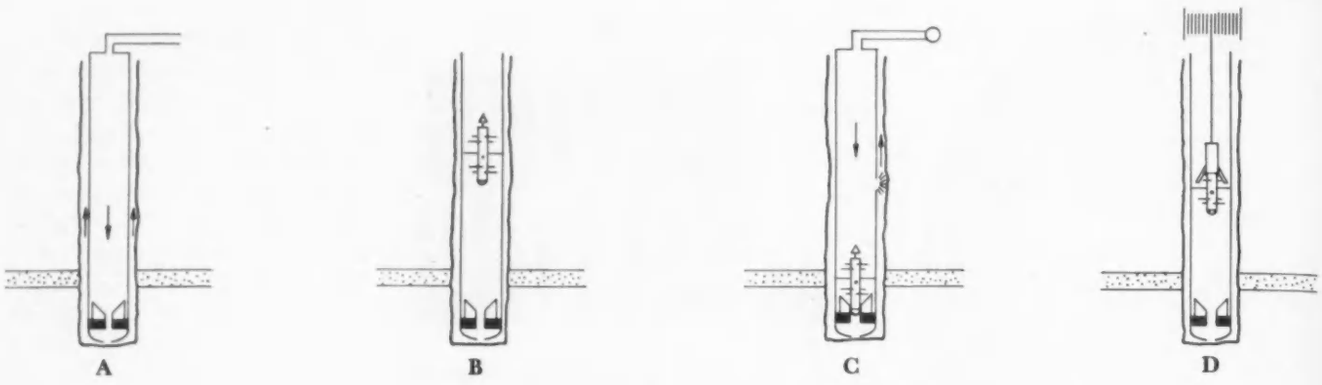

Figure 4—Down-hole casing testing tool permits testing casing string in the hole before it is cemented.

A drillable seat (A) is placed above the collar or shoe. Casing is run joint by joint as shown. When the casing is on the bottom, drilling fluid is circulated in the usual manner. (B) Tool is dropped into the casing to seat it at the bottom. (C) A pressure test is made. Dropping the tool can be made at any time during the running of the casing. If pressure test indicates a faulty joint, the casing can be pulled for replacement of the joint. (D) After a satisfactory test, the tool is recovered by a sand line or wire line. Casing can then be cemented in the usual manner.

9. Ultra-sonic wave analysis.
10. Down-hole casing testing tool.

• **Visual Inspection**—It is logical that all casing be examined or "eyeballed" before being run in the hole. It is also logical however, that in many instances field conditions will not allow a proper examination. Poor lighting conditions at night, cold weather, rain and wind, are but a few of the adverse circumstances causing the inspection to be glossed over.

• **Hydrostatic pressure testing**—Testing casing on the pipe racks in the field using a high pressure pump is well known and widely used and 1 to 6 percent of casing is rejected. The prime advantage of this method is detection of flaws before the casing is run in the hole.

• **The magnetic powder method**—A method whereby a magnetic powder is applied to the surface and the magnetic field lines are found out of place where a flaw occurs. This has the advantage of being non-destructive.

• **Magneto-inductive and electrical methods**—Included under this heading are coil magnetization, current flooding and induced magnetism. Many excellent adaptions for testing casing have evolved from these fundamental forms. These have again the advantage of being non-destructive.

• **The penetration method**—This is based on very old practices wherein the casing is sprayed, painted or submerged in a liquid indicator. The indicator enters the cracks by capillary action and after the surface is cleaned, the cracks may be seen or detected. Color, fluorescence, and nuclear detection have been ideas attributable to these old methods.

• **Packer testing**—This is a very well known and popular method of testing tubular goods. Many types of packers as well as varieties of methods are in existence today. The wireline retrievable packer is proving highly successful and a specific set-up of packers is gaining wide use for in-the-hole testing of threads. Packers are used in the detection and cure as well as the prevention of casing failure.

• **X-ray analysis**—Casings are tested to a limited extent by X-ray examination. Its advantage is that it provides pictures which can be evaluated, and again is non-destructive.

• **Gamma-ray analysis** — Radioactive substances such as C_o60 C_s137 and I_r192 supply gamma rays for this method.

• **Ultra-sonic wave analysis** — Sound waves from an emitter are deflected at a flaw and a receiver may either show a wave shadow or reflection (Figure 3). This method is gaining in popularity, is highly sensitive and quick.

• **The down-hole casing testing tool**—This is a new patented adaptation of the bath-tub stopper. The process involves testing the made-up string of casing while it is in the hole but before it is cemented. Should a failure be detected, the casing can be pulled, the faulty joint replaced, and the string re-tested (Figure 4). The method is cheap and eliminates the human factor for error.

About the Author

Larry C. M. Darling is president and general manager of Macro Limited, Calgary, Alberta, Canada. He is a graduate in geology and petroleum engineering from Alberta and Texas universities and has been active in the oil business since 1951.

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How to unitize in a hurry

Here's the way one company obtained 75 percent approval from 650 royalty owners in one-third the normal time

By Russell J. McLellan
Unitization Coordinator
Phillips Petroleum Company
Bartlesville, Okla.

ONE OF THE difficult problems in unitization is approval of the proposed unit by a large number of owners in any particular field.

Few, if any, working interest owners are opposed to unitization. Royalty owners who are less familiar with unitized secondary recovery or pressure maintenance operations are reluctant to lend their support to such a program.

Royalty owner resistance to unitization can be eliminated by following one simple procedure: Provide complete information and education on the benefits to be derived from participation in a unitized secondary recovery or pressure maintenance operation.

To illustrate this point, following are case histories on two unitization programs. It will take little imagination to determine in which instance the correct approach was used:

Case History #1. In the fifth enlargement of the Southwest Antioch Gibson Sand Unit in Garvin County, Oklahoma seven years ago, 482 royalty owners were contacted and approval obtained from 75 percent; 53 percent by mail and 22 percent by personal contact.

Total time required: 17 weeks.

Case History #2. Phillips Petroleum Company recently devised a carefully planned program whereby more than 650 royalty owners were contacted in the Panther Creek Hart Sand Unit, also in Garvin County. Approval was obtained from 75 percent of the owners on an acreage basis.

Total time required: Six weeks.

This represents a record accomplishment in royalty unitization. In fact, an analysis of several unitization projects created in the past few years, shows that the Panther Creek field was unitized in about one-third the normal time.

How Phillips unitized. The Panther Creek project was unitized under the Oklahoma law which requires approval of at least 63 percent of both royalty and working interest owners on an acreage basis, and subsequent approval by the Oklahoma Corporation Commission. The unit area covers 6,640 acres and contains 166 producing tracts on 40-acre spacing.

The first step in securing royalty owner approval was a meeting with officers of the local Royalty Owner Association. At this meeting, a petroleum engineer explained the necessity for unitization to arrest declining production and income, the predicted increases in oil production and revenue from the unitized water flood program, and the basis for dividing the increased oil and revenue among the many owners in the field.

The Plan of Unitization, the legal document necessary to accomplish unitization, was explained by an attorney and a staff member who later contacted some of the royalty owners in person. This meeting resulted in approval and support by the board of directors of the Royalty Owner Association and aided immeasurably in securing approval by individual members of the Royalty Owner Association.

> **"The key to royalty owner approval is complete information and education on the benefits to be derived from participation in a unitized secondary recovery or pressure maintenance program."**

The second step in securing approval of royalty owners was a letter to which was attached the Plan of Unitization and a Royalty Owner Ratification Form. This letter covered in detail the purpose of the unitization, the necessity for creating the unit, a forecast of when increased oil production would be expected, the ultimate increase in oil recovery anticipated, and a simple example illustrating how a royalty owner could easily determine his share of the increased oil reserve and the dollar value of the increased oil.

Much dissatisfaction, misunderstanding and delays, and unnecessary correspondence can be eliminated by including in the letter a detailed explanation of all factors vital to the royalty interest. The willingness of Phillips and other operators in the Panther Creek Hart Sand Unit to give the royalty owners an estimate of the recoverable secondary oil and dollar value of such production instead of a mere statement that a "substantial increase" in ultimate recovery is expected, is probably the most significant part of the letter to the royalty owner and in the entire program of securing royalty owner approval.

Immediate results. Between 35 and 45 percent of the royalty ownership on an acreage basis had returned approved Royalty Owner Ratification Forms within the first two weeks after the letter containing the detailed explanation and request for approval was mailed. An additional 10 percent of the royalty ownership was received by mail as the result of a follow-up letter, and the balance required for approval by the Oklahoma Corpora-

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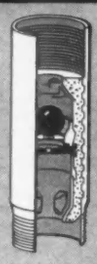

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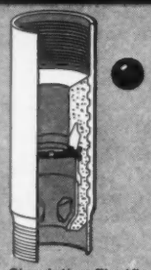

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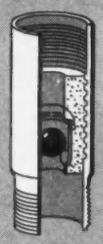
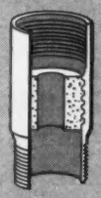
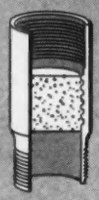
Fill-Up Collar
Product No. 161-D M&F



Cement Float Collar
Product No. 101 M&F

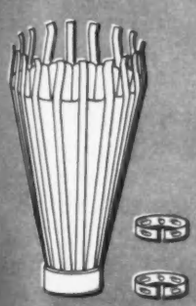


Cement Baffle Collar,
with Hole
Product No. 104 M&F

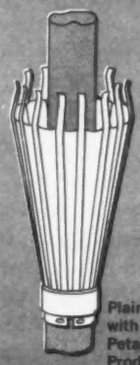


Cement Baffle Collar,
Solid
Product No. 105 M&F

Triplex
Flapper Valve
Float Collar,
Product No. 134 M&F



Metal Petal Basket,
with Stop Rings
Product No. 343



Plain Hook-Up Nipple
with Metal
Petal Basket
Product No. 330

The only complete line of
Primary Cementing Equipment
available through your
supply store.

BAKER

OIL TOOLS, INC.

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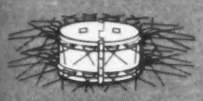
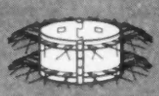


Hinge-Lok Wall
Scratcher, with
4½" long wires
Product No. 900-C

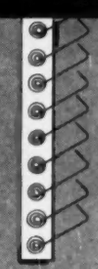


Hinge-Lok Wall
Scratcher, with
2½" long wires
Product No. 900-C

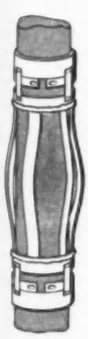
Solid-Ring Wall
Scratcher, with
4½" long wires
Product No. 901-C

Solid-Ring Wall
Scratcher, with
2½" long wires
Product No. 901-C

Auto-Grip
Stop Rings
Product Nos.
938 (Solid)
and 939 (Split)



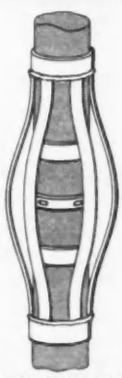
Rotating
Wall Scratcher
Product No. 903



"G-12" Slim Hole
Casing Centralizer
Product No. 910-G

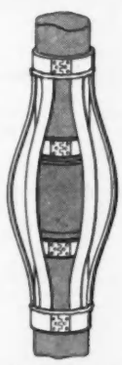
"G-20" Solid-Ring
Casing Centralizer
Product No. 910-G

"HN-15" Solid-Ring
Casing Centralizer
Product No. 908-HN



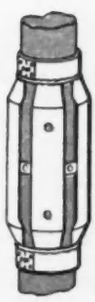
"HN-20" Solid-Ring
Casing Centralizer
Product No. 908-HN

"H-15" Hinge-Lok
Casing Centralizer
Product No. 9115



"H-20" Hinge-Lok
Casing Centralizer
Product No. 9112

"H-25" Hinge-Lok
Casing Centralizer
Product No. 9113

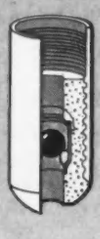


Hinge-Lok Rigid
Casing Centralizer
Product No. 9133

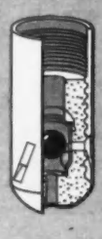
Triplex Cementing Shoe Product No. 1363

Differential
Fill-Up Shoe
Product No. 1081

Flexiflow
Fill-Up Shoe
Product No. 160



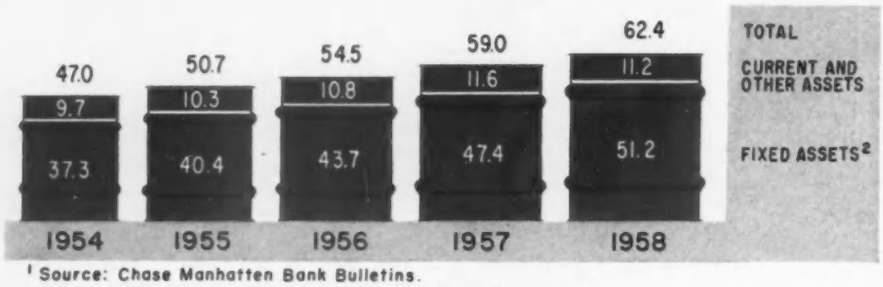
Cement
Float Shoe
Product No. 100



Cement Wash-Down
Whirler Float Shoe
Product No. 120

Cement
Bull Plug Shoe
Product No. 103

Cement Guide Shoe
Product No. 102



[1] Source: Chase Manhatten Bank Bulletins.

[2] Gross Fixed Assets Include Property, Plant And Equipment.

Oil industry investments jump 32.8% in five years

GROSS INVESTMENT in the U.S. oil industry increased $3.4 billion during 1958, boosting the total to $62.4 billion by year's end. This compares with a $4.5 billion increase in 1957 and $3.8 billion in 1956.

The total gross investment included $51.2 billion in property, plant and equipment, and $11.2 billion in current and other assets.

In the five-year period, 1954-1958, total gross investment in the U.S. oil industry increased 32.8 percent, from $47 billion to $62.4 billion. Investment in property, plant and equipment increased $13.9 billion or 37.3 percent.

These statistics are included in the annual financial analyses of the oil industry published by the Chase Manhattan Bank. The 1958 report was prepared by Frederick G. Coqueron, Norma J. Anderson and Richard C. Sparling.

Departmental investments. Of the $51.2 billion of gross investment in property, plant and equipment at the end of 1958, $29.4 billion or 57.4 percent of the total was in crude oil and natural gas production.

Gasoline and cycling plants accounted for $1.2 billion or 2.4 percent of the total. Investment in refineries and chemical plants totaled $9.2 billion or 18.4 percent. Marketing totaled $5.4 billion or 10.5 percent, and transportation $4.95 billion or 9.7 percent.

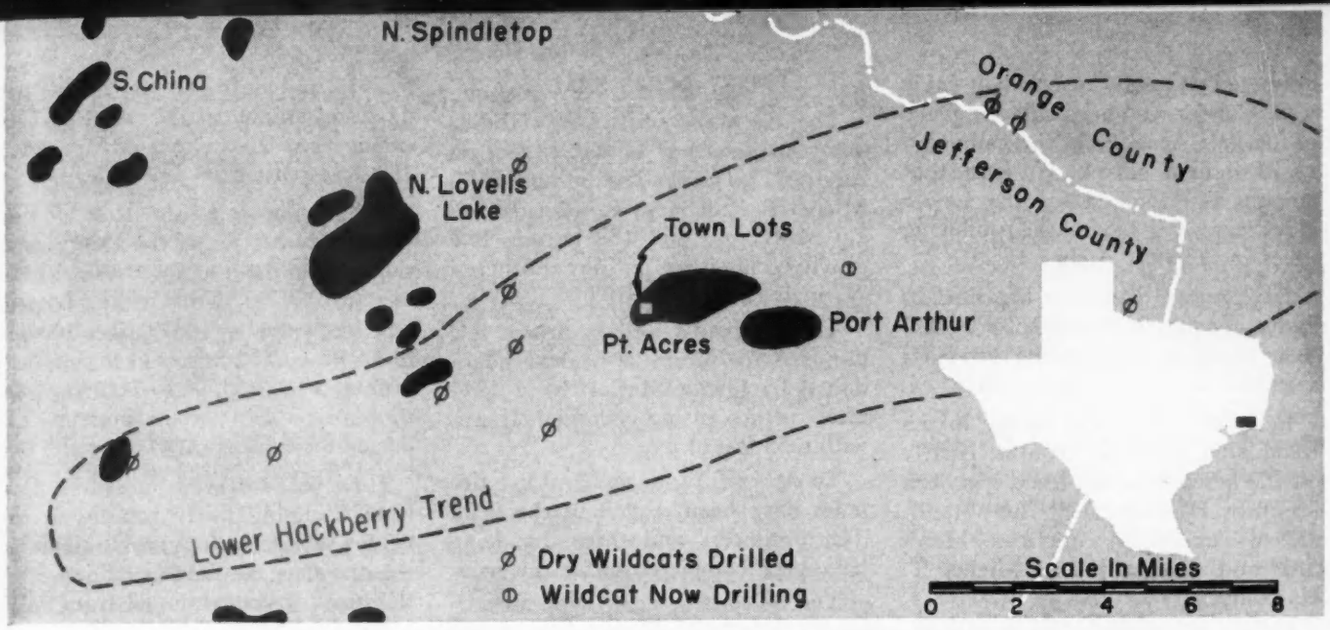
Expenditures in 1958. The U.S. oil industry spent $5.3 billion for facilities and equipment during the recession months of 1958, $1.1 billion less than the amount spent in 1957, and $400 million or 7 percent less than the yearly average of $5.7 billion for 1953-1957.

The 1958 expenditures included $3.575 billion, or 67.5 percent of the total, for crude and natural gas production; $75 million or 1.4 percent for gasoline and cycling plants; $725 million or 13.7 percent for refineries and chemical plants; $375 million or 7.1 percent for transportation facilities; $400 million or 7.5 percent for marketing, and $150 million or 2.8 percent for miscellaneous items.

How Oil Industry Money Is Spent for Property, Plant and Equipment*

Department	ESTIMATED EXPENDITURES						ESTIMATED INVESTMENT ON DEC. 31, 1958			
	1958		1957		1954		Gross		Net	
	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total
†Crude and Natural Gas Prod.	3,575	67.5	4,400	68.8	3,700	69.1	29,400	57.4	13,975	53.6
Gasoline and Cycling Plants	75	1.4	125	1.9	100	1.9	1,200	2.4	600	2.3
Transportation	375	7.1	360	5.6	350	6.5	4,950	9.7	2,850	10.9
Pipe Lines	225	4.2	275	4.3	275	5.1	3,525	6.9	2,150	8.2
Marine	125	2.4	70	1.1	50	0.9	1,050	2.1	525	2.0
Other	25	0.5	15	0.2	25	0.5	375	0.7	175	0.7
Refineries and Chemical Plants	725	13.7	950	14.9	800	15.0	9,425	18.4	4,825	18.5
Marketing	400	7.5	475	7.4	350	6.6	5,400	10.5	3,350	12.8
Others	150	2.8	90	1.4	50	0.9	825	1.6	500	1.9
Total, All Departments	5,300	100.0	6,400	100.0	5,350	100.0	51,200	100.0	26,100	100.0

* Chase Manhattan Bank Bulletins, 1953-1958. † Expenditures include cost of drilling dry holes, but exclude exploration expenses and lease rentals charged to income account. Investment includes only natural gas producing, transmission and distribution facilities of oil companies.



Location of Dry Wildcats Drilled to Establish Lower Hackberry Trend

New fields spur gas search along Texas Gulf Coast

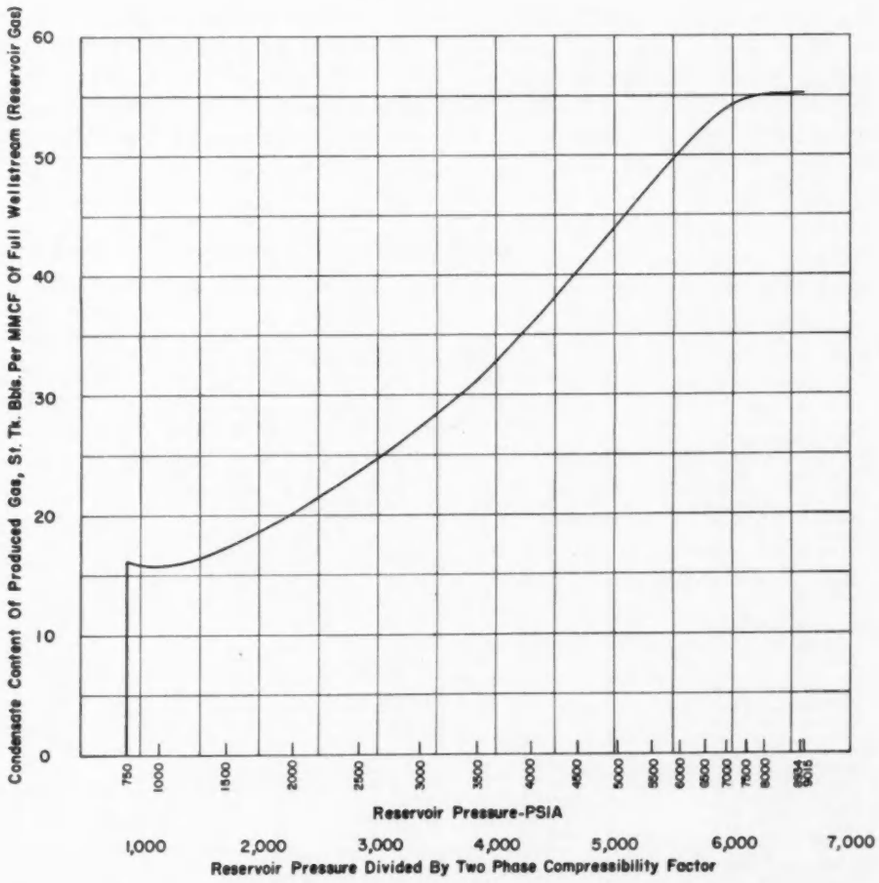
Operators are attempting to establish a Lower Hackberry trend in Jefferson and Orange Counties

By Don E. Lambert
WORLD OIL Staff

ALTHOUGH UNSUCCESSFUL in 10 wildcat attempts, operators are continuing their efforts to prove up a downdip Hackberry trend indicated by the recent discovery of two of the most promising gas condensate fields along the Texas Gulf Coast in 10 years.

There are two reasons for the stepped up activity: (1). The Port Acres Field, discovered by Meredith and Company in August 1957. (2). The Port Arthur Field, discovered by the same operator in September 1958.

Gas reserves in the two fields are



Port Acres Field. Lower Hackberry reservoir stock tank condensate content of produced gas under depletion operation.

estimated at nearly one trillion cubic feet. Condensate originally in place in the Port Acres Field was estimated at 24 million barrels. At least that amount is estimated for the Lower Hackberry and Nodosária producing zones in the Port Arthur Field.

Exploratory drilling is expected to increase over an area about 4 to 5 miles wide, and extending 20 miles east and west of the two fields.

Lease play has been heavy in the trend area in recent months. Nearly all the acreage in the trend has been leased by Humble, Shell, Sun, Standard of Texas, Pan American, Meredith and Company and Michel T. Halbouty.

Only a few of the town lot exceptions to Rule 37, ranging from 4 acres down to ¼ acre in size, remain unleased in the Port Acres and Port Arthur fields. Town lot operators, whose water well rigs dot the western edge of the Port Acres field in profusion, have been successful so far in blocking attempts to obtain pressure maintenance and cycling operations in the field.

To date, seven wildcat wells have been drilled up to 20 miles west of the two fields, and three wildcats up to 10 miles east. All were dry. One wildcat is now drilling two miles east of the Port Acres field. Meredith and Company is the operator.

PORT ACRES FIELD

The discovery well, Lum C. Edwards 1, blew out at 10,534 feet on August 17, 1957. The second well, Michel T. Halbouty's Rosen 1, flowed 2.5 MMcf gas and 162 barrels 48.8 gravity condensate per day through a 9/64-inch choke from 10,687 feet.

The Halbouty well is just a few hundred feet from a wildcat abandoned by Glenn McCarthy in 1944 after surface casing collapsed. It was within 35 feet of pay.

To date, 26 producers and five dry holes have been drilled in the field. Ten producers and three dry holes have been completed so far this year.

The 3,000-acre field, with an estimated 500 billion cubic feet of gas reserves, has been drilled up with exception of town lot wells which account for only a small percentage of the field's proven area.

Three town lot wells have been completed—all producers. A large number of water well rigs are now drilling on the town lot sites to hold the leases.

Exclusive of the town lots, there are six operators in the field: Bob Martin, Meredith and Company, Pan American, Humble, Michel T. Halbouty and Peter Henderson Oil Co.

Well data. Wells in the field are rich in condensate content, producing 3.25-3.5 million cubic feet of gas per day and 56-60 barrels of 48.8-53.2 gravity condensate per MMcf on a 160-acre pattern.

Production is from the Lower Hackberry Section of the Frio formation at depths ranging from 10,400 feet to 10,700 feet. Initial bottom hole pressures at 10,600 feet for the first two wells completed in the field averaged 9,015 psia—about 4,000 psia above the normal pressure expected for this depth.

However, reservoir pressures have been declining fairly rapidly in the field. On February 1, 1959, about 18 months after the field was discovered, the pressure had dropped from 9,015 psia to 8,360 psia. Since that time, the pressure has been falling at the rate of about 3.5 pounds per day. Sample tests indicate that 7,500 psia is the critical point below which fall out of condensate in the reservoir will be heavy.

Structural conditions. On the east the field is limited by a major fault, and along the north and west by a strand line where the sand probably pinches out.

A second major fault traverses the field on the south in an east-west direction, with a displacement ranging from 100 feet on the east to more than 300 feet on the west. This dis-

Port Acres Field Completion and Test Information

Operator and Well	Date of Completion	Kelly Bushing Elevation Feet	PERFORATED INTERVAL		INITIAL TEST INFORMATION							
			Electric Log Depth Feet	Subsea Depth Feet	Date of Test	Choke Size Inches	Flowing Tubing Pressure PSIG	Gas Prod. Rate MCF/Day	Cond. Prod. Rate Bbls./Day	Gas-Cond. Ratio Cu. Ft./Bbls.	Cond. Gravity °API	Absolute Open Flow Potential MCF/Day
Michel T. Halbouty												
American Nat. Ins. No. 1	1-14-58	18	10,694-10,704	10,676-10,686	1-18-58	10/64	6,904	3,455	173	20,000	50.2	30,000
Rosen, H.M., et al No. 1 (Original)	11-10-57	17	10,696-10,704	10,679-10,687	11-12-57	9/64	7,204	2,485	162	15,350	48.8	78,000
Rosen, H.M., et al No. 1 (Workover)	5-12-58	17	10,634-10,658	10,617-10,641	5-15-58	Adj.	6,152	5,890	375	15,700	50.4	40,000
Rosen, H. M., et al No. 2	3-11-58	18	10,584-10,606	10,566-10,588	3-19-58	Adj.	7,194	4,400	277	15,900	52.8	122,000
Rosen, H. M., et al No. 3	8-6-58	17	10,662-10,685	10,645-10,668	8-26-58	13/64	6,467	5,805	323	18,000	52.0	68,000
Rosen, H. M., et al No. 4	10-23-58	18	10,586-10,610	10,568-10,592	10-29-58	Adj.	6,879	6,220	361	17,200	50.2	450,000
Rosen, H. M., et al No. 5	12-28-58	21	10,614-10,624	10,593-10,603	1-10-59	Adj.	6,906	3,770	190	19,850	51.1	105,000
Rosen, H.M., et al "A" No. 1	6-6-58	21	10,454-10,458	10,433-10,437	6-11-58	Adj.	6,152	4,750	303	15,700	50.4	11,400
Rosen, H.M., et al "A" No. 2	2-1-59	21	10,580-10,599	10,559-10,578	2-13-59	Adj.	6,451	5,470	276	19,800	51.0	96,000
Shelby, J. T. No. 1	4-29-58	17	10,630-10,644	10,613-10,627	5-3-58	Adj.	6,821	5,610	313	17,900	51.6	70,000
Peter Henderson Oil Co.												
Judice No. 1	10-28-58	18	10,581-10,601	10,563-10,583	11-11-58	Adj.	6,966	6,140	400	15,350	52.1	225,000
Sassine No. 1	2-10-59	20	10,548-10,568	10,528-10,548	3-11-59	Adj.	6,568	6,690	436	15,350	52.1	122,000
Humble Oil & Refining Co.												
Port Acres Gas Unit 1, No. 1	11-21-58	16	10,560-10,596	10,544-10,580	11-30-58	.....	6,365	7,772	464	16,750	51.4	35,000
Port Acres Gas Unit 2, No. 1	12-30-58	15	10,548-10,598	10,533-10,583	1-6-59	.....	6,582	4,820	284	17,000	52.1	70,000
Meredith and Company, et al												
Edwards, Lum C. No. 1 (Original)	8-17-57	17	Well blew out at total depth of 10,534 ft.				No Back Pressure Test was made on this Completion.					
Edwards, Lum C. No. 1 (Sidetrack)	6-2-58	17	10,625-10,635	10,608-10,618	6-3-58	12/64	7,074	2,940	206	14,300	51.0	36,000
Edwards, Lum C. No. 2	10-2-58	20	10,598-10,612	10,578-10,592	10-13-58	Adj.	6,808	6,900	348	19,800	51.2	48,000
Edwards-Shelby Unit 1, No. 1	4-20-58	18	10,665-10,671	10,647-10,653	4-21-58	10/64	6,660	3,330	212	15,700	50.4	25,000
Shelby, J. T. No. 1	1-4-58	17	10,637-10,656	10,620-10,639	1-10-58	Adj.	6,626	6,780	438	15,500	.....	56,000
Pan American Petroleum Corp.												
Gilbert Fee No. 1	11-16-58	18	10,671-10,682	10,653-10,664	12-2-58	Adj.	6,310	4,360	241	18,100	53.2	92,000
Gilbert Fee No. 2	12-29-58	16	10,650-10,683	10,634-10,667	3-16-59	Adj.	4,800	2,218	110	20,100	52.0	13,400
Ward No. 1	12-8-58	20	10,530-10,549	10,510-10,529	12-19-58	14/64	6,673	6,722	445	15,100	50.7	265,000

placement may or may not be a sealing fault, depending on the sand development along it.

While the field has not been completely defined by drilling on the south and southwest, and along parts of its western limits, it is believed that the reservoir will not extend too far beyond its present known limits.

Net gas thicknesses, including stringer and main sands, range from 10 feet in Halbouty's Rosen 1 in the northeast section of the field, to 114 feet in Pan American's Ward 1 well on the west.

Excellent markets. The Port Acres field is in the center of a huge industrial area, providing excellent markets for both gas and distillate. All of the Port Acres production is sold intrastate.

United Gas Pipe Line Company is purchasing gas from all the wells in the field except those owned by Peter Henderson Oil Company. Gas from the Henderson wells is purchased by Texas Gas Corporation.

As of March 1, 1959, 16 billion cubic feet of gas had been produced from the field, and 883,000 barrels of condensate. During February, withdrawals amounted to 68,820 Mcf per day.

Typical drilling program. Port Acres operators usually set 10¾-inch surface casing at 1,800 feet; 7-inch protection string at 10,200 feet; and 5-inch liner from 10,200 feet to TD.

Drill pipe used: 4½-inch to 10,200 feet; 2⅞-inch or 3½-inch to TD. Normally, five 6¼-inch to 7½-inch drill collars are used to 10,200 feet.

In both the Port Acres and Port Arthur fields, operators use one or two 15½-inch rock bits to 1,800 feet; from ten to twelve 9⅞-inch bits to 10,200 feet; and one to four 6⅛-inch bits to TD. From one to seven 6⅛-inch bits are used in the Port Arthur field.

Because of the high reservoir pressure, mud control is critical at Port Acres. The Port Acres discovery well blew out at 10,512 feet using 16.8 ppg mud. A well blew out in the Port Arthur field at 11,400 feet using 17.3 ppg mud.

In both fields, operators normally use 9.8 ppg phosphate mud to 8,000 feet, then break over to lime base oil emulsion mud and build weight to 13.3 ppg to 10,200 feet at Port Acres or 10,600 feet at Port Arthur. Usually mud weights of 17.5 ppg are used from those depths to TD.

The high mud weights cause some circulation problems. They are controlled by:

- Pulling the drill pipe up in the 7-inch casing and letting the mud stand for a few hours.
- Use of lost circulation material.
- Cementing off the zone and redrilling, if necessary.

Completion program. The wells are cased and perforated. Swabbing is not necessary.

There are no particular cementing problems. About 400 sacks of slow set cement are used for the 7-inch oil string and 1,000-1,500 sacks are used to set the surface pipe.

Equipment used. Jack-knife rigs capable of drilling to 14,000 feet are used in both fields. Some medium size rigs are also used. Gas and butane are the most common fuels. Gas lines are available for most of the rigs.

Three 3,000-pound working pressure blowout preventers are used to 10,200 feet and three 5,000-pound preventers from 10,200 feet to TD. Mud weight and pit level indicators are used as additional protection against blowouts. Steel mud pits are used.

Surface canals and shallow wells (200-250 feet) provide water for the rigs.

Rig time and costs. Average rigging up time is 3½-4 days. Completion time from spudding in to tanks is 37 days at Port Acres, 41 days at Port Arthur.

Minimum costs for wells in both fields range from $175,000-to-$225,000 or more for a dry hole—$250,000 to $325,000 for a producing well.

Prevailing footage rates are $4 per foot to 10,200 feet. Day rates vary from $950 to $1,150, according to depth.

Mud costs range from $27,500 to $40,000, depending on hole size and trouble encountered.

PORT ARTHUR FIELD

The discovery well, Doornbos 1, was completed last September—the only completion in 1958. Four wells have been completed to date.

Currently, two wells are testing and three are drilling. No wells are producing as yet. Operators are waiting for a suitable gas purchase contract.

Operators with completed wells include Meredith and Company, Pan American, Michel T. Halbouty and Kilroy Oil Company. Texas Company and the others, with the exception of Kilroy, are all currently drilling in the field.

The entire area has been leased up, with the exception of some town lots. However, the town lots are ½ to 1 mile from production. There are two principal landowners in the area, William Doornbos and the City of Port Arthur. The City owns royalty in one of the completed wells.

Structural conditions. The Port Arthur and Port Acres fields are about ½-mile apart. The Port Arthur structure is on the coast side of a 500-foot fault separating the two fields.

There are several pay sands in the field, with production indicated from the Lower Hackberry and Nodosaria sections of the Frio formation. One of the recently completed wells encountered upwards of 200 feet of total pay sands. However, the amount of pay varies from well to well.

Nearly 500 billion cubic feet of gas reserves have been proven up in the now known 800-acre limit of the field. Although the field limits have not yet been determined, operators believe it will not be as large as Port Acres in area, but will contain more total pay.

Condensate is estimated to be 60 barrels per million cubic feet of gas in the Lower Hackberry—and 35 barrels per million cubic feet in the Nodosaria.

Because of the fault conditions, pay zones are deeper at Port Arthur than at Port Acres. Top of the pay sands are from 11,000 feet to 12,100 feet, compared with 10,450 feet to 10,650 feet at Port Acres. With this exception, drilling and completion requirements are about the same in both fields.

Bottom hole pressure in the Lower Hackberry section appears to be 9,300 psi-10,200 psi in the Nodosaria. There is no declining history as yet. However, operators expect steady declines after production has started.

—**The End**

Earnings remain good after increasing in first half

By L. J. Logan
Associate Editor, WORLD OIL

AS MEASURED by results for 38 companies, oil industry earnings in the first half of 1959 were 26 percent better than in the initial half of 1958. They would have had to be 25 percent larger than they were, however, to equal those in the first half of 1957.

For the 38 companies, profits in the second quarter of 1959 were 31 percent greater than in the like period of 1958, which was the poorest quarter in recent years. In the first quarter of 1959, industry profits had been about 20 percent above the recession marred initial quarter of 1958. (WORLD OIL, June 1959, Page 151.)

A declining trend in oil industry earnings started in the third quarter of 1957 and continued for a full year. Recovery commenced in the third quarter of 1958, with earnings substantially better than in the second quarter of 1958 for most oil companies of all classes. Better volume and better prices aided them all. The earnings continued to improve in the fourth quarter of 1958, with net income larger than in the third quarter for a large majority of companies.

The profits further increased moderately in the 1959 first quarter over the fourth quarter of 1958. In the second quarter of 1959 the earnings were 31 percent above the like period a year earlier, but they were lower than in the first quarter of 1959, due to seasonally lower sales volumes and lower prices of products and some crude oils. The second quarter brings the lowest levels of demand for petroleum each year.

A relatively favorable trend of earnings is continuing in the third quarter of 1959 and likely will continue in the fourth quarter. However, gains over 1958 henceforth cannot be expected to be as large as those in this year's first and second quarters. For, as indicated above, recovery already was under way in 1958's third and fourth quarters. This year's third and fourth quarters will be comparing with the relatively good ones of 1958.

Net Earnings of Some Oil Companies in Second Quarter and First Half, 1959 vs. 1958

(All "per share" data based on number of shares of common stock outstanding June 30, 1959)

	SECOND QUARTER					FIRST HALF				
	$ Thousand		$ Per Share		%	$ Thousand		$ Per Share		%
COMPANY	1959	1958	1959	1958	Diff.	1959	1958	1959	1958	Diff.
Anderson-Prich	1,697	718	.96	.37	+136	3,044	1,377	1.71	.71	+121
Argo Oil Corp.	976	830	.50	.43	+ 18	2,411	2,330	1.24	1.20	+ 3
Ark. Fuel Oil	1,129	1,018	.30	.27	+ 11	3,029	3,323	.80	.87	— 9
Ashland O. & R.	3,368	1,315	.49	.16	+156	7,301	3,780	1.10	.66	+ 93
Atlantic Ref. Co.	4,498	4,972	.46	.52	— 10	16,400	7,667	1.74	.78	+114
Cities Service Co.	5,243	11,114	.49	1.06	— 53	18,904	24,618	1.76	2.34	— 23
Clark O. & R.	502	63	.34	.05	+697	1,006	222	.68	.16	+353
Colorado O. & G.	609	265	.15	.04	+130	1,034	595	.24	.10	+ 74
Continental Oil	14,254	9,509	.68	.48	+ 50	29,160	20,208	1.38	1.03	+ 14
*Creole Pet. Corp.	.....	74,692	...	.96	.....	115,500	117,200	1.49	1.51	— 1
Delhi-Taylor Oil	d1,049	d469	d.20	d.08	.....	1,460	d715	.28	d.13	.....
Felmont Pet. Corp.	527	227	.14	.06	+132	1,315	942	.34	.24	+ 39
Gulf Oil Corp.	75,141	55,069	2.32	1.70	+ 36	141,814	115,737	4.38	3.57	+ 23
*Humble O. & R.	.....	.....	...	...	.....	88,994	57,182	1.23	.79	.....
*Imperial Oil	.....	9,131	...	.29	.....	.....	24,153	...	.77	.....
*International Pet.	.....	.....	...	...	.....	10,100	9,000	.69	.62	.....
La. Land & Expl.	4,904	4,061	.54	.46	+ 21	9,169	8,861	1.02	.99	+ 3
Maracaibo Oil	73	48	.15	.10	+ 52	139	139	.28	.28	.....
Ohio Oil Co.	8,358	6,719	.63	.51	+ 24	18,556	15,087	1.41	1.15	+ 23
Phillips Pet. Co.	27,376	15,895	.80	.46	+ 72	53,209	36,412	1.55	1.06	+ 46
Pure Oil Co.	7,557	5,943	.86	.69	+ 27	13,148	10,675	1.51	1.24	+ 23
Quaker State	556	522	.68	.63	+ 7	1,004	811	1.22	.98	+ 24
Richfield Oil	5,110	4,804	1.26	1.20	+ 6	10,695	10,410	2.65	2.60	+ 3
Shell Oil Co.	34,720	19,182	1.15	.63	+ 81	69,187	45,752	2.28	1.51	+ 51
Signal O. & G.	4,329	4,117	.50	.47	+ 5	8,658	8,326	1.00	.96	+ 4
Sinclair Oil	9,848	8,399	.64	.55	+ 17	27,032	22,356	1.76	1.45	+ 21
Skelly Oil	7,828	4,535	1.36	.78	+ 73	14,523	10,549	2.52	1.83	+ 38
Socony Mobil	31,900	26,100	.66	.54	+ 22	77,100	63,000	1.59	1.30	+ 22
Standard, Calif.	60,556	59,325	.96	.94	+ 2	118,153	116,735	1.87	1.85	+ 1
Standard, Ind.	34,167	20,991	.95	.94	+ 63	78,851	52,423	2.20	1.47	+ 50
Stand. Ky.	3,479	3,061	1.34	1.18	+ 14	6,743	6,301	2.59	2.42	+ 7
Standard, N. J.	148,000	103,000	.69	.48	+ 44	315,000	249,000	1.47	1.16	+ 27
Standard, Ohio	4,785	4,036	.95	.80	+ 19	13,290	11,436	2.67	2.29	+ 16
Sun Oil Co.	10,747	5,386	.92	.46	+100	21,974	11,560	1.87	.98	+ 90
Sunray Mid-Cont.	10,193	9,598	.49	.45	+ 6	19,936	19,251	1.05	1.01	+ 4
Texaco, Inc.	71,503	68,532	1.23	1.17	+ 4	162,723	138,536	2.79	2.37	+ 17
Texas Gulf Prod.	873	452	.22	.11	+ 93	2,092	1,617	.52	.40	+ 29
Texas Pac. C. & O.	1,621	857	.42	.24	+ 89	3,642	2,353	.94	.65	+ 55
Tidewater Oil Co.	8,137	d524	.50	...	.....	18,600	279	1.24	...	.....
Union Oil Calif.	5,881	5,462	.72	.70	+ 8	10,772	11,457	1.32	1.40	— 6
Union O & G, La.	3,025	1,875	.64	.39	+ 61	6,675	4,091	1.41	.86	+ 63
Universal Consol.	941	641	.98	.67	.....	1,721	1,123	1.79	1.17	+ 53
*Total 38 Companies	613,362	467,648	...	...	+ 31	1,309,470	1,038,624	...	...	+ 26

* Creole, Humble, Imperial, and International Pet. are excluded from totals, being included as affiliates of Standard (N.J.).
d Deficit.

Results for 38 companies. As shown in the table herewith, 38 oil companies in the first half of 1959 earned $1,309,470,000. That was an increase of 26.1 percent over the $1,038,624,000 that they earned in the initial half of 1958.

The same 38 companies had combined earnings of $613,362,000 in the second quarter of 1959. That was an increase of 31.2 percent over the $467,648,000 that they earned in the second half of 1958.

Earnings have been substantially improved in 1959 for almost all oil companies. Increases around the industry averages have been reported by numerous companies, including some of the international, domestic integrated, producing and refining companies.

Exceptionally sharp gains include those of Anderson-Prichard Oil Corporation, Ashland Oil & Refining Company, The Atlantic Refining Company, Sun Oil Company, and Tidewater Oil Company. —**The End**

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THE HOMCO WASHOVER BACK-OFF CONNECTOR RECOVERS THE PIPE

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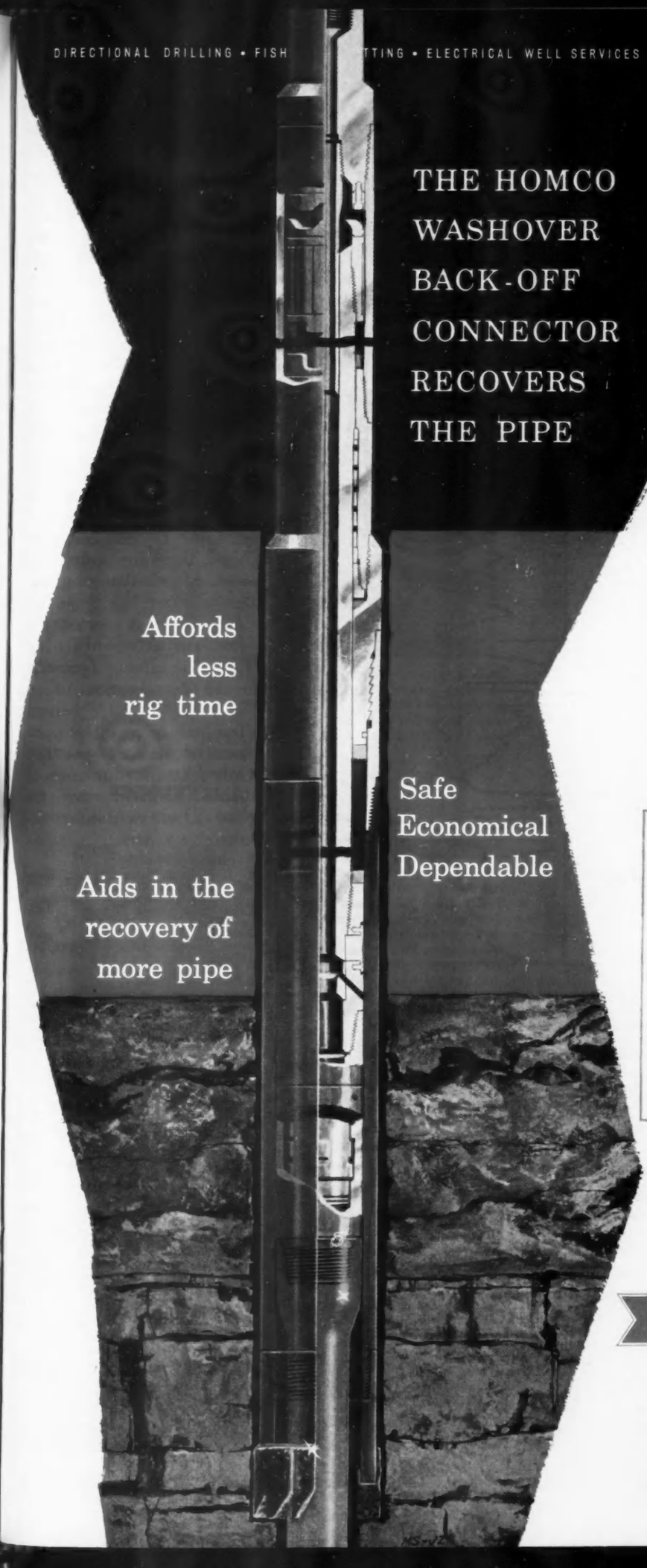

Affords less rig time

Safe Economical Dependable

Aids in the recovery of more pipe

The HOMCO Washover Back-Off Connector is designed to safely increase the rate of recovery of stuck drill pipe or tubing in washover operations.

The basic function of the connector is to enable the operator to washover and back-off with the string shot, recovering the "fish" with one round trip of the drilling string, thus saving rig time.

On an actual fishing job, through the use of the HOMCO Washover Back-Off Connector and HOMCO String Shot, only seventeen trips were necessary to recover 9,188 feet of pipe. A total of 207 hours of rig time was used. Without the use of the HOMCO Washover Back-Off Connector and String Shot a total of 34 trips would have been required and 412 hours of rig time would have been used to accomplish the same job.

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WRITE FOR TECHNICAL BULLETIN NO. 27-1-1

Sonic log proves valuable porosity tool

Continued from Page 68

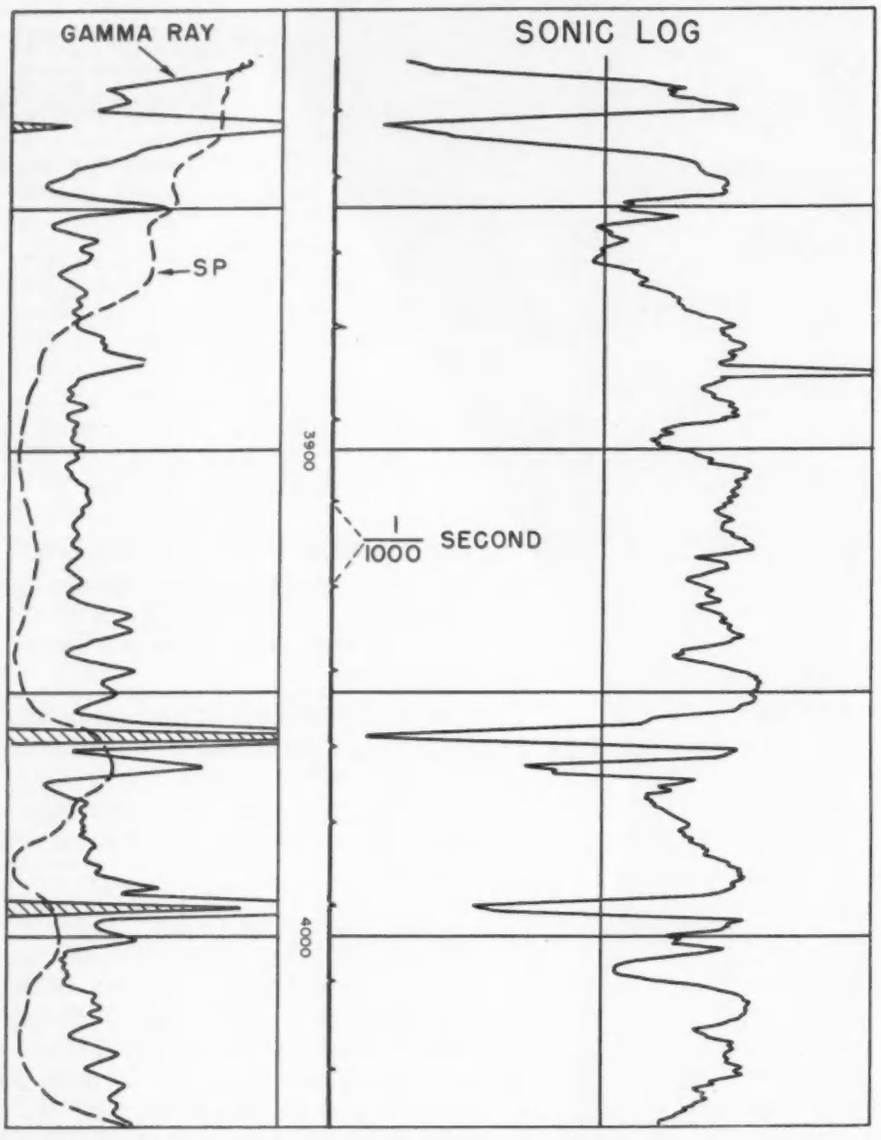

FIGURE 7—This integrated log is most useful in geophysical work since total travel time may be determined for any portion of the hole. When a log of this type is run, the total travel time between any two points is obtained quickly by totaling the "pips" between points. This integrated time and conventional velocity survey data agree closely. For more precise geophysical work the log should be supplemented with geophone check shots.

The linear relation between porosity and the recorded curve facilitates computation in both high and low porosity ranges.

• Formation changes are delineated sharply. The log is focused such that only the short zone between receivers affects the reading. Borehole characteristics have no effect except at depths where hole diameter changes.

• Correlation is good. The uniformity of sonic parameters of formations permits both local and regional correlation. Also, correlations have been particularly effective in evaporite sections.

• Excellent velocity data is provided for geophysical application. Total travel time determination is available and can be recorded as the log is run.

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Combatting Lost Circulation

Continued from Page 72

the same formulation with 8 percent gel, have greater strengths than the subject blend. It might be concluded, then, that they had sufficient strength. Many times operators have used cements having strengths less than expected. If low-strength cement is left behind a surface or protection casing, it is a good idea to "tail in" with 50 to 100 sacks of neat cement for additional strength. If, on the other hand, the casing is a production string, it is advisable to leave the weaker cement with better perforating characteristics around the shoe.

Proper water-to-cement ratio is far more important than strength to the success of a cement job.

Of the major cement combinations discussed, those containing diatomaceous earth, pozzolans, and expanded perlite retard the deterioration of API Class A cement in brackish and sulfate-containing waters. Those containing bentonite accelerate the deterioration of all cements in these corrosive waters. Gilsonite has little or no effect upon the resistance of the basic portland cement. Only diatomaceous earth, of these admixes, will improve the resistance of a sulfate-resistant cement to corrosive waters.

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another
TRETOLITE SERVICE
report

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The following four production aids have been field-proved by billions of barrels of treated crude—and have saved producers literally billions of dollars over the years.

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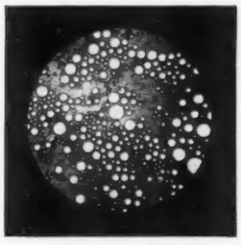
Demulsifiers



The first chemical demulsifier used in the petroleum industry for the recovery of emulsified crude oil was invented by William S. Barnickel, founder of the Tretolite Company. Since then, TRET-O-LITE demulsifiers have rendered useful millions of barrels of crude oil that might otherwise have been lost. Today, many TRET-O-LITE formulas are available not only for the recovery of emulsified production, but also for salt removal from crude oil, and useful oil salvage from tank bottoms and slop oil systems.

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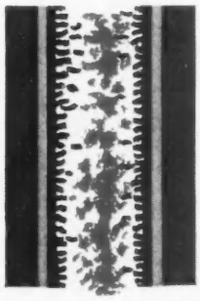

Tretolite Company research and field engineering developed the first organic corrosion inhibitors specifically for petroleum equipment and pioneered their first application. Today, KONTOL Corrosion Inhibitors are used in the production (as well as refinery and pipeline) departments of leading oil companies everywhere.

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Because Tretolite has developed and pioneered the application of these products, this organization can offer you a brand of experience and service in the manufacture, use and know-how of these products that's unequalled anywhere else in the industry.

For further information on how these and other money-saving Tretolite aids can fit into *your* operation, *ask the Man in the Red Car*—your own Tretolite Field Service Engineer.

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How to produce high pour point, waxy crude

Continued from page 98

used as a primary source of oil heating at Red Wash. This method was developed as an expedient where other methods failed. The use of these cables is expensive since heating loads are high when the cables are energized. The average flowline heating load varies between 25 and 40 kilowatts, depending on the length of flowline.

Other methods are being used on off-setting properties having a small number of wells without a network of flowlines and oil gathering systems. One system is an oil traced insulated surface installation. This lease did not have electric power and the cost of installation would have been prohibitive. The system has one advantage over burying the pipe, and that is accessibility. It is always above ground and can be maintained easily. The cost of such a system is high due to insulation and triple pipe strings. Line heaters still are used to heat the trace oil instead of the production.

The Red Wash Unit is mostly federal lands covered by the multiple use law. A large network of traced surface lines obviously would not allow other surface use.

Since the majority of heat transfer comes directly from conduction due to close physical contact, the problem of keeping the trace lines and the production line in close proximity underground still is a major consideration. Past experience with steam trace lines indicates that movement of the lines due to expansion and contraction will cause separation unless some restraining method is used. A separation of only a few inches will nullify effective heat transfer. Consideration has been given to the use of some of the new aluminum alloy piping currently offered. A built-in trace line now is available in sizes up to and including 4-inch, with pressure ratings satisfactory for flowline use. In this case, if a reusable trace fluid such as a light oil were used, a separate trace return line would be laid with the main flowline. Since the heating trace is part of the flowline itself, very litle effect would be lost from migration of the return line. This system appears to have the greatest promise of any of the fluid trace methods available.

About the Author

J. J. Dremer, general engineer, Red Wash district, Standard Oil Company of California, Western Operations, Inc., received a B.S. degree in mechanical engineering in 1944 from Oregon State College. He worked in the San Joaquin Valley oil fields as a field engineer for two years, gaining experience in various phases of producing activities. He was transferred to the San Francisco office in 1956 as staff engineer. The last 2½ years has been spent at Red Wash as general engineer, responsible for surface construction and planning. He is a registered professional mechanical engineer in the state of California.

Processing and shipping. All oil produced at Red Wash is gathered to one spot either by a network of pipe lines or by trucking. The major part of the field is covered by an oil gathering system but a few of the outlying wells still must be handled by truck. Oil lines are treated in the same manner as a well flowline insofar as heating and tracing are concerned.

The central battery is merely a stocking point for the crude prior to shipment. Four 10-foot treaters handle all oil to be transported by pipe line. The treaters and tankage all are heated by steam from a central boiler plant. The main oil lines in the entire plant are traced with inside steam lines in the event of a shutdown.

Crude is shipped to a main pipe line through 7½ miles of 3 and 4-inch line, both of which are heated at stations located 2½ miles apart. After a shipment of Red Wash crude, both lines are purged with Rangely to eliminate any possibility of plugging. Circulation in the branch lines is maintained between shipments to keep up ground and pipeline temperature.

The main pipe line is not heated so when Red Wash crude is shipped, it must be batched with Rangely in a 70-30 ratio. Experience indicates that anything above 30 percent Red Wash tends to become a calculated risk. Studies now are in progress to find other methods of pumping Red Wash in greater concentrations.

—**The End**

How to unitize in a hurry

Continued from page 104

tion Commission was obtained by personal contacts.

The procedure followed in securing approval of royalty of the Panther Creek Hart Sand Unit reduced the number of personal contacts required to about 10 percent of the number formerly required.

However, where there are a number of people involved, as is the case with unitization, there almost always will be a small minority, sometimes working interest owners, who for one reason or another refuse to cooperate or who cannot be located or whose identity is not known. It is for this reason that pooling or unitization statutes are needed which allow the project to proceed when some substantial majority of the working interest owners and royalty owners have approved.

The Oklahoma unitization statute fixes this majority at 63 percent in interest of the working interest owners and 63 percent in interest of the royalty owners. Normally the percentage approval actually obtained in the case of units formed under the Oklahoma law is 90 to 100 percent approval of working interest owners and 75 to 85 percent approval by royalty owners. The existence of the law encourages some to sign who might otherwise be among the hold-out minority.

Experience with many unitization efforts proves that for the most part "royalty owners are reasonable people" if properly informed on the purpose, the necessity and the benefits of unitized secondary recovery or pressure maintenance operations. The working interest owners have the duty and responsibility of properly informing the royalty owners. —**The End**

What's Happening

among MEN in the INDUSTRY

R. B. O'Connor has been named area geophysicist in **Shell Oil Company's** Houston Area Exploration Department. He succeeds **G. F. Pirsig** who will go to **Shell Oil Company of Canada, Limited,** in the same capacity.

Owen L. Hill

Owen L. Hill has been appointed financial vice president, treasurer and a member of the board of directors of **Clark Oil & Refining Corporation.** In 1949 Hill joined Seaboard Oil Company and after a series of promotions was advanced to secretary-treasurer. When Seaboard was acquired by Texaco in 1958 he was transferred from Dallas to New York.

Loren L. Ware

Sinclair Oil & Gas Company, Tulsa, has elected **Loren L. Ware** a member of the board of directors. Ware remains at his present position as vice president in charge of exploration for Sinclair. Ware became a vice president in July, 1958, when he was transferred to Tulsa.

Dan B. Treece, scout for **The Carter Oil Company,** has been transferred from Miles City to Bismarck, N. D. He has been replaced by **Walter A. Chapman, Jr.,** formerly of Bismarck.

M. J. van Loben Sels has been elected a director of **Buttes Gas & Oil Company** to fill a vacancy on the board created by the resignation of **M. C. C. van Loben Sels.**

The American Oil Company has announced the appointment of **H. W. Crawford** as manager, administrative, for the New York region of that firm. Crawford succeeds **R. L. Forslund** who is assigned to the position of special assistant, marketing in Amoco's New York general office.

H. E. Prokesh, Fort Worth, has been promoted to manager of exploration for **Continental Oil Company's** southwestern region. Also, **G. H. Swenumson,** division geophysicist, Roswell, N. M., has been promoted to regional geophysicist at Fort Worth, replacing Prokesh. **V. H. Waddell,** Midland, Texas, geophysical supervisor, succeeds Swenumson at Roswell as division geophysicist.

Robert U. Blum, president of **Creole Explorations, Inc.,** has been named a director of **Petrosur Oil Corp.**

Donald B. Lamont has been elected vice president and director of **San Jose Petroleum, Incorporated.** Prior to joining San Jose, Lamont was an independent oil operator in Los Angeles.

Donald B. Lamont

John O'Hern

The American Bank of Commerce, Odessa, Texas, has announced that **John O'Hern,** former owner of O'Hern Drilling Company, has joined the administrative staff.

Robert E. Lampkin

Robert O. Albert

Robert E. Lampkin has been named general manager and technical advisor for domestic and foreign operations, and **Robert O. Albert** has been named manager of the Buenos Aires, Argentina, laboratories of **Petroleum Technologists, Incorporated.**

J. Creig Coogan

Ray G. Marvin

King Stephenson Oil Company has announced the appointments of **J. Creig Coogan** as production manager and chief engineer with offices in Oklahoma City, and **Ray G. Marvin** as division geologist, assisting **Jack E. Trigg,** manager of the company's Rocky Mountain & Williston Basin Division, with headquarters in Denver.

Harold Svoboda, manager of production, has been elected vice president of **Sunset International Petroleum Corp.** Svoboda, who will continue to be in charge of all oil and gas production, joined the company as a petroleum engineer seven years ago.

Dr. Robert R. Wheeler, consulting geologist, has opened an office for independent operations, including domestic and foreign exploration in the Meadows Building in Dallas.

Continental Oil Company has announced the promotion of two men in key jobs in the Southwestern Region Exploration Department. **A. R. Ratti,** formerly assistant division land superintendent for Conoco's Midland Division, promoted to general landman for the Southwestern region, with offices in Fort Worth. **E. W. Whisenand,** landman at the Midland Division, promoted to assistant division land superintendent, succeeding Ratti.

Paul D. Balbin has been promoted to general manager of **Chaco Petroleum, S. A.,** Bolivian subsidiary of **Tennessee Gas Transmission Company.**

King-Stevenson Oil Company, Inc., has announced the election of **Harry R. Ferris** as vice president and treasurer. Ferris previously was vice president, secretary and treasurer of Webcor, Inc.

Harry R. Ferris

D-X Sunray Oil Company has announced the election of **J. Floyd Ladd** as treasurer succeeding the retired **B. P. (Bert) Lambert. Lewis Lacy** has been elected secretary and **L. Millard Gelvin** assistant treasurer. Both Lacy and Gelvin hold similar posts with **Sunray Mid-Continent Oil Co.,** the parent company of D-X Sunray.

Lyman C. Dennis has joined **Grabol Oil Corporation,** Tulsa, as manager of exploration. Dennis had been staff geologist for Wilcox Oil Co. since February 1958 and before then had worked for Russell Maguire, independent, Wichita Falls, Texas, and The Pure Oil Co.

Texaco, Inc., has announced the election of two new officers. They are **C. N. Brooks,** vice president, Foreign Operations, Eastern Hemisphere, and **Greer W. Orton,** treasurer. **Stanley T. Crossland,** vice president and treasurer since 1955, was named vice president, Finance and Economics.

Robert A. Forsman has been elected president of **Oildex Corporation,** Tulsa. Forsman also heads **Win-Well Manufacturing Company.**

Dean A. McGee, president, **Kerr-McGee Oil Industries, Harold E. Purdy,** regional manager, **Standard Oil Co. (Indiana),** and **Stanley D. Breitweiser,** vice president, **D-X Sunray Oil Co..,** were elected trustees of **Midwest Research Institute,** Kansas City, Mo.

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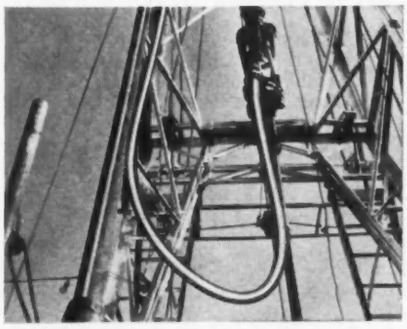

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Edward L. Steiniger, president and director of **Sinclair Oil Corporation,** has been named to the newly-created Board of Lay Trustees of Fordham University. Steiniger is a director of the American Petroleum Institute, a member of the Pan-American Society, the Newcomen Society and the Economic Club of New York and is a board member of the National Industrial Conference Board.

Edward L. Steiniger

T. C. Bascom and **Alan D. Durland** have been appointed assistant treasurer and assistant secretary, respectively, of **Parker Drilling Company,** Tulsa.

Petroleum Exploration, Inc. of Texas, has announced the addition of two exploration personnel to their staff. **Clifford K. Holloway** has accepted the position of senior staff geologist in the Amarillo, Texas, office and **J. R. (Bob) McLean, Jr.,** formerly with Gulf Oil Corporation's land department in Roswell, N. M., and Amarillo, has joined Petroleum Explorations as landman in Amarillo. McLean replaces **A. E. Whitehead** who has been transferred to Calgary, Alberta, Canada, as Land Representative for the company's Canadian operations.

Donald M. West has been transferred to Turkey as exploration manager for **Mobil Exploration Mediterranean, Inc.** in Ankara. West has been in charge of exploration activities in Libya, for Mobil Oil of Canada Ltd. (Libya branch).

J. W. Haslett, manager of **Shell Oil Company's** methods and procedures department, head office, New York, has contributed chapters to two textbooks just published by **Prentice-Hall, Inc.**

Esso Research and Engineering Company has named **Dr. Harvey E. W. Burnside,** Locust, N. J., and **William P. Drews,** Westfield, N. J., engineering associates in the firm. The positions are awarded to scientists and engineers with outstanding technical abilities.

Associated Gas & Oil Company, Inc., has announced the election of four new directors to the board. **Walter N. Maguire** and his son **Walter L. Maguire,** both of Stamford, Conn.; **B. T. Parr** and **Judge L. M. Fischer,** both of Corpus Christi, Texas.

Kirby Petroleum Company has moved a portion of its Tulsa staff to its headquarters office in the Tennessee Building in Houston. Accounting and land records have been consolidated in the Houston office. **Warren F. Johnston,** assistant secretary-treasurer, has moved to the Tennessee Building. Geological and exploration, under **E. P. Neal,** vice president and division manager, and production and evaluation, under **C. K. Smith,** division production superintendent, remain in Tulsa.

Prince Marine Drilling & Exploration Company, Houston, has elected **Walter N. Maguire, Walter L. Maguire,** both of Stamford, Conn., and **Stanley A. Wickstrom** as directors.

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Wireline Engineers, S. A.
CASPER, WYOMING—C. A. White.....3-5264
CORPUS CHRISTI, TEXAS—Tolle, Inc...TE 5-5367
FARMINGTON, NEW MEXICO
B & R Service, Inc.....DA 5-2393
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Assoc. Eng. & Eqpt., Inc.....CA 5-1103
HOUSTON, TEXAS
Mid-Western Well Ser. Co.....RE 4-4262
HOUSTON, TEXAS
Long Line Production Co.....GR 3-5739
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
Cameo, Inc.....CE 5-3124
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H. A. Nelson, vice president, **Blackwell Oil and Gas Company,** Tulsa, has been elected a director of the company succeeding **A. B. Imel,** Cushing, Okla., who resigned. Also elected a director was **Burch Williams** of the firm of **Reinholdt and Gardner,** St. Louis.

T. G. Kelliher

Henry H. Neel

Tidewater Oil Compaany has named a new foreign exploration and production department manager and a new exploration manager for domestic operations. **Henry H. Neel, former** Tidewater exploration manager, has been appointed manager of foreign exploration and production for the company, and **T. G. Kelliher** has been named manager of exploration, replacing Neel.

Shell Oil Company has announced three staff changes in its exploration and production organizations. **O. L. Odale,** production manager for the Denver area, has been named manager of the Pacific Coast area. He succeeds **W. F. Bates,** who has been placed on special assignment on the staff of the vice president for this area. **J. W. Inkster,** exploration manager in Tulsa, moves to Houston in the same capacity. He replaces **M. S. Metz,** who will be on special assignment with Shell's head office exploration organization. **R. L. Trott,** executive assistant to the vice president, Tulsa, will assume a similar position in Houston.

Frank W. Kroll, Jr., Thomas H. Sonnichsen, Jr., Theodore J. Stenuf, Norman Alpert, Earl Vincent Clark, Newbold O. Cross, James Parker Forsman, George Franz Lewenz, William Frederick Overberger and **Leo Alexander Rapoport** have joined the staff of the **Esso Research and Engineering Company.** The firm is the major scientific and engineering affiliate of Standard Oil Company (New Jersey).

Texas Pacific Coal and Oil Company has announced the re-election of all four directors. **H. B. Fuqua,** board chairman, **W. R. Berger,** Fort Worth geologist, **Sid W. Richardson,** Fort Worth oil and gas producer, and **A. H. Rowan,** Rowan Drilling Company, Fort Worth.

Samuel H. Elliott, who has been vice president, marketing, of **Standard Oil Company (Ohio),** has been designated senior vice president, exploration and production.

Dillon Glendinning has been appointed treasurer of **Mobil International Oil Company,** the international operating division of **Socony Mobil Oil Company, Inc.**

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DIAMOND BITS DIAMOND CORING
WELL LOGGING CORE ANALYSIS

Signal Oil and Gas Company has named **Daniel S. Johnston** vice president in charge of production. Signal also announced that all officers and director were re-elected at the company's 36th annual meeting.

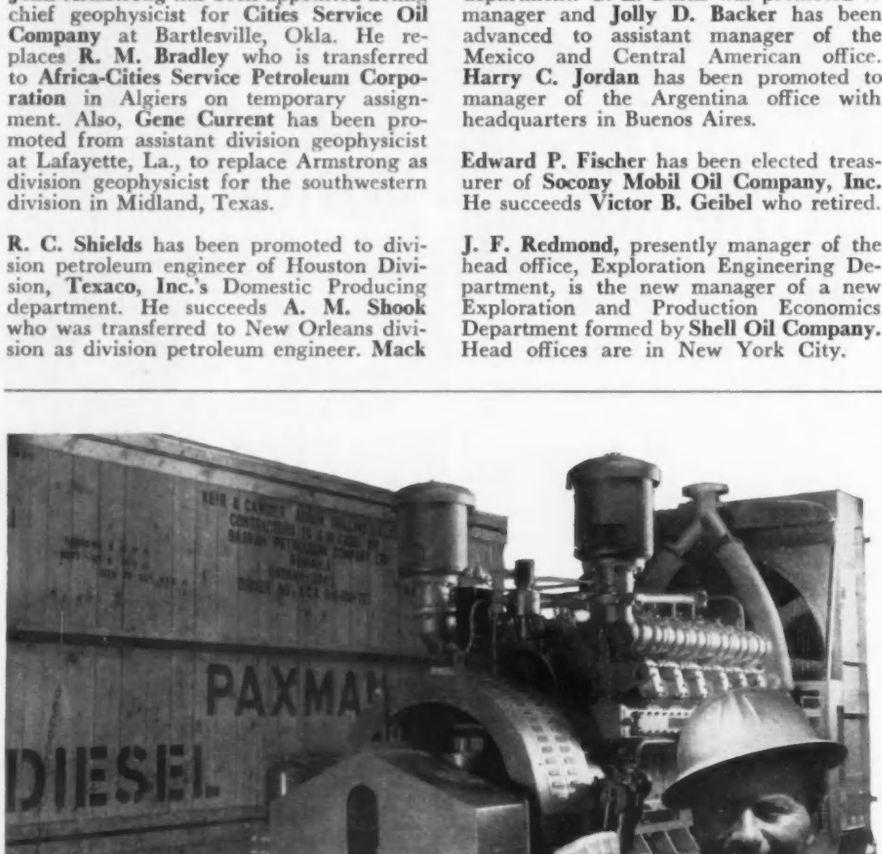
John Armstrong has been appointed acting chief geophysicist for **Cities Service Oil Company** at Bartlesville, Okla. He replaces **R. M. Bradley** who is transferred to **Africa-Cities Service Petroleum Corporation** in Algiers on temporary assignment. Also, **Gene Current** has been promoted from assistant division geophysicist at Lafayette, La., to replace Armstrong as division geophysicist for the southwestern division in Midland, Texas.

R. C. Shields has been promoted to division petroleum engineer of Houston Division, **Texaco, Inc.'s** Domestic Producing department. He succeeds **A. M. Shook** who was transferred to New Orleans division as division petroleum engineer. **Mack G. Trusdel** has been appointed district superintendent, Harvey district of the New Orleans Division.

Phillips Petroleum Company has announced new appointments in its recently organized foreign sales and development department. **G. L. Burns** was promoted to manager and **Jolly D. Backer** has been advanced to assistant manager of the Mexico and Central American office. **Harry C. Jordan** has been promoted to manager of the Argentina office with headquarters in Buenos Aires.

Edward P. Fischer has been elected treasurer of **Socony Mobil Oil Company, Inc.** He succeeds **Victor B. Geibel** who retired.

J. F. Redmond, presently manager of the head office, Exploration Engineering Department, is the new manager of a new Exploration and Production Economics Department formed by **Shell Oil Company.** Head offices are in New York City.



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John H. Childs has been named general manager of advertising and sales promotion for Texaco, Inc. Childs is a former vice president of Cunningham & Walsh Inc., New York advertising agency.

Crescent Petroleum Corporation has announced the appointment of **W. F. Styler, Jr.,** as financial vice president. The appointments of **R. N. Tuggle** as treasurer and **W. M. Leitner** as controller were also announced.

H. W. Baker has been appointed superintendent of **Phillips Petroleum Company's** North Central Texas production district. He replaces **C. L. Montgomery,** who retired. **C. D. Dohrer** succeeds Baker as assistant district superintendent.

Pacific Petroleums Ltd., has named **Kelly H. Gibson,** prominent Canadian oil man, a vice president and a director.

L. E. Fitzjarrald is one of the six new vice presidents of **Phillips Petroleum Company** recently elected by the board of directors following the company's annual stockholders meeting.

W. O. Ham, Jr., Houston, has been promoted to general manager of **Continental Oil Company's** southwestern region, with headquarters at Fort Worth.

Standard Oil Company (Indiana), has announced the appointment of **George V. Myers,** formerly vice president for production, to fill the post as executive vice president which has been vacant for the past two years.

Sinclair Oil & Gas Company has announced the promotion of **Robert D. Sprague** to assistant chief geologist at Tulsa. Also, three exploration department employes have been transferred to Anchorage, Alaska, to the land office. They are: **Richard L. Porter, Ross Roger Gahring** and **Fred B. Jones, Jr.**

The Carter Oil Company has announced a number of personnel changes in the company's Exploration Department. **S. W. Stone,** Shreveport, La., has been transferred to Billings, Mont., as division geologist to replace **L. T. Hart** who has assumed new duties in connection with special stratigraphic studies conducted in Billings; **J. C. McCulloch,** division geologist, Denver, moved to Tulsa as assistant to the chief geologist; **J. D. Langston,** Rawlins, Wyo., replaces McCulloch in Denver; **J. D. Coffman,** Wichita, Kan., assumes Langston's position as district geologist at Rawlins.

C. J. Guzzo, vice president in charge of domestic marketing for **Gulf Oil Corporation,** has been designated a senior vice president, and **J. L. Lenker,** currently a vice president and director of **British American Oil Company, Ltd.,** Toronto, Canada, has been elected a vice president of Gulf.

Robert E. Hedberg has been appointed executive secretary of the **Engineers Club of Tulsa, Inc.,** succeeding the late **Harold T. (Jack) Frost. Miss Jeanne Frost** will continue in her capacity of recording secretary.

Sinclair Oil & Gas Company has announced personnel changes in the Jackson division of the company. **Robert L.**

Schmidt, senior geophysicist, was promoted to division geophysicist, succeeding **William J. Robinson**, who recently was promoted to staff geophysicist and transferred to Tulsa; **William H. Hollingsworth,** district geologist, was promoted to division geologist, succeeding **Charles C. Barber,** transferred to New Orleans; **George R. White,** senior geologist, was named district geologist, succeeding Hollingsworth; **L. Graham Hughes,** intermediate geologist at Jackson replaces White as senior geologist and **James L. White,** junior geologist was promoted to the position vacated by Hughes.

Paul E. Taliaferro has been elected president and chief executive officer of **Sunray Mid-Continent Oil Co.** by the board of directors. **C. H. Wright** was re-elected chairman, and **R. W. McDowell,** president of DX Sunray Oil Co., wholly owned subsidiary, was re-elected vice chairman. All other officers were re-elected. Taliaferro succeeds **W. C. Whaley,** president for the past seven years who has retired.

James R. (Jimmie) Day has announced the opening of an office as a consulting geologist in the First National Bank Building, Midland, Texas. He was previously with Rycade Oil Corporation and Amerada Petroleum Corporation and district geologist for Pan American Co., in Abilene, Texas.

Deaths

Guy Porter Slater, 79, Odessa, Texas, a former Tulsa oil derrick manufacturer, and owner of the **Sun Rig Company** at Odessa, died June 1 in Odessa.

Rollin A. Waltz, 67, who retired from **Pan American Petroleum Corporation** in Tulsa two years ago, died in Houston June 4.

James E. Bradshaw, 53, former vice president of **Glenn Drilling Company,** died June 8 in Tulsa following a long illness.

Albert L. Walters, 61, West Coast secretary of the **Liquefied Petroleum Gas Association,** died June 10 in Portland, Ore.

John M. Minor, recently named vice president of **Lane-Wells Company,** died in a plane crash in Peru June 24. Miner was on an inspection trip of South American oil fields.

James Mason Gantt, 43, assistant exploration manager for **Standard Oil Company of New Jersey in Cuba,** died June 28 in Havana after a brief illness.

James J. Jones, 78, independent consulting geologist, died June 29 as the result of injuries received in an automobile accident.

Harry C. (King) Pouder, 82, president of **Pouder-Pomeroy Oil Company,** died July 1 in Tulsa after a long illness.

N. Barney Feagin, 79, owner and president of **Feagin Investment and Oil Company,** Tulsa, died July 2.

Harvey Ellis Davidson, 55, chief engineer of **Bethlehem Steel Company, Supply Division,** died recently in a Tulsa hospital.

WHO'S MEETING WHERE

SEPT.	
9–12	**AAPG Intermountain Association 1959 Field Trip, Provo, Utah.**
14–17	**Texas Mid-Continent Oil & Gas Association 40th Annual Meeting, Rice Hotel, Houston.**
16–18	**National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N.J.**
16–18	**Wyoming Geological Association, 1959 Field Conference, Cody, Wyo.**
20–23	**ASME, Petroleum Division, Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.**
24–25	**Louisiana-Arkansas Division of Mid-Continent Oil & Gas Association, Annual Meeting, Roosevelt Hotel, New Orleans.**
27–29	**National Association of Oil Equipment Jobbers, Annual Convention and trade show, Hotel Leamington, Minneapolis, Minn.**
27–30	**API, Executive Committee of Board of Directors, Greenbriar Hotel, White Sulphur Springs, W. Va.**
29–Oct. 1	**NACE, Western Region Conference, Bakersfield, Inn, Bakersfield, Calif.**
OCT.	
1– 3	**National Association Petroleum Landmen, Southwestern Legal Center, Dallas.**
2– 3	**Desk and Derrick Clubs of North America, 8th Annual Convention, Hilton Hotel, San Antonio, Texas.**
4– 7	**Society of Petroleum Engineers of of AIME, 34th Annual Fall Meeting, Dallas.**
5– 7	**NACE, Northeast Region Conference, Lord Baltimore Hotel, Baltimore, Md.**
8–10	**AAPG, 2nd Annual Meeting of the Southwestern Federation of Geological Societies, Lubbock, Texas.**
8–10	**Ninth Annual Drilling Symposium, Pennsylvania State University, University Park, Pa.**
8–11	**Third Biennial Louisiana Gulf Coast Oil Exposition, Blackham Coliseum, Lafayette, La.**
11–13	**AAODC, 19th Annual Meeting, Skirven Hotel, Oklahoma, City.**
12–14	**Eighth Annual Clay Conference, Oklahoma University, Norman, Okla.**
12–15	**NACE, South Central Region Conference, Cosmopolitian Hotel, Denver.**
20–22	**NACE, North Central Region Conference, Cleveland, Ohio.**
22–23	**Society of Petroleum Engineers of AIME, Los Angeles Basin Section, Fall Meeting, Huntington-Sheraton Hotel, Pasadena, Calif.**
28–30	**AAPG, Mid-Continent regional Meeting, Broadview Hotel, Wichita, Kan.**
29–30	**Oil Recovery Symposium on Southwest Texas, Corpus Christi.**
Nov.	
4– 6	**Rocky Mountain Oil and Gas Association, 14th Annual Convention, Cosmopolitian Hotel, Denver**
5– 6	**AAPG, Pacific Section Regional Convention, Ambassador Hotel, Los Angeles.**
9–11	**API, 39th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotel, Chicago**
9–12	**SEG, International Meeting, Biltmore Hotel, Los Angeles.**
10–11	**API, Board of Directors Meeting Conrad Hilton Hotel, Chicago.**
11–13	**Gulf Coast Association of Geological Societies, Executive Committee, Coliseum, Houston.**
19–21	**Gulf Coast Association of Geological Societies Convention, Biloxi, Miss.**

Nomads' Chapter monthly meeting: Los Angeles, second Wednesdays, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

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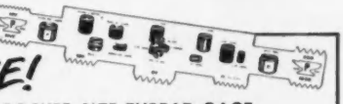

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Next, he can help you select the addition agents to make the special acid formulation needed for your well.

Then he can study other well characteristics. He can help you decide on the size of the treatment and the injection rate required. If stage treatments are needed, he can help you arrive at a procedure to be followed. He provides you with Dowell's vast experience in acidizing.

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SILICATE CONTROL ACID contains an addition agent that shrinks water-swollen clays or prevents their swelling during treatment. In addition, it is designed to break emulsions. In many instances, Silicate Control Acid has given excellent results in fields where regular acid actually reduced production.

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RADIATOR SPECIALTY CO.
Charlotte, North Carolina

what's Happening

among INDUSTRY ASSOCIATIONS

Houston Chapter of NOMADS Entertains Foreign Guests

Foreign guests were present at the July meeting of the Houston Chapter NOMADS. Seated left to right: Jack Morris, Drilling & Exploration Company, Dallas; Aberbal Almedia, production engineer, Petrobra, S. A.; Bolivar Guerra, drilling engineer, Petrobras, Brazil; Arthur Prell, drilling engineer, Mene Grande Oil Company, Maracaibo, Venezuela. Standing, left to right: O. W. Ward, vice president, Tennessee Gas & Oil Co., Calgary, Alta.; Harvey McCarthur, production superintendent, Superior Oil Co., of Maracaibo, Venezuela; Dr. Charles F. Hiller, vice president, University of Houston; Wm. K. Kinnedy, engineer, S.I.E., Calgary, Alta.; Keoshi Sekijima and Bunkichi Okino, Japan Petroleo Exploration Company.

Petroleum Engineers to Meet In Dallas' Memorial Auditorium

The Bullwheel Barbecue October 5 in Dallas' new Memorial Auditorium will be the opening party of the Thirty-Fourth Annual Meeting of the Society of Petroleum Engineers of AIME. Dates for the meeting are October 4-7.

More than 3,500 engineers and their wives are expected. The auditorium has been designated as general headquarters for the meeting. Technical study presentations divided into eight categories plus a full schedule of social activities are on the program. A breakfast dance the evening of October 6 will highlight the entertainment.

Weldon Porter, Welex, is general chairman. R. J. Bathancourt, Sun Oil Co., is his administrative assistant.

Society of Professional Well Log Analysts Perfects Organization

The Society of professional Well Log Analysts was organized at a recent meeting in Tulsa.

New officers are: F. S. Millard, The Carter Oil Co., president; G. T. N. Roberts, Shell Oil Co., first vice president; R. G. Hamilton, consultant, second vice president; J. H. Blackburn, Sunray Mid-Continent Oil Co., secretary-treasurer; L. G. Chombart, consultant, editor. Other executive committee members are G. W. Haynes, Pan-American Petroleum Co., W. B. Belknap, Phillips Petroleum Co., and Jack Duren, Shell Oil Co.

Corrosion Control Short Course Set Sept. 22-23 in Shreveport

The eighth annual Corrosion Control Short Course for the oil and gas industry will be held September 22-23 at Centenary College in Shreveport, La. The course is sponsored by the Shreveport section of the National Association of Corrosion Engineers in cooperation with Centenary.

Oil Scouts and Landmen Elect W. J. Garrison

Oil Scouts and Landmen have elected W. J. (Sam) Garrison, a career scout, as president.

Garrison becomes chairman of the executive board, which directs publication of the Oil Scouts Year book, an annual five-pound record of oil and gas development in the United States and Canada.

The Association will officially change its name to International Oil Scouts Association on Jan. 1, 1960, when new officers begin their terms.

Garrison succeeds William P. Alllen, Imperial Oil Limited. Garrison, assistant chief scout, has worked for Humble Oil & Refining Company, Houston, for 25 years.

T. O. Hall, Houston, Named SEG President for Coming Year

Exploration geophysicists the world over have elected T. O. Hall, Houston, president of the Society of Exploration Geophysicists for next year, it has been announced by E. V. McCollum, Tulsa, cur-

New Officers for West Coast Production Division of API

West Coast District, American Petroleum Institute Division of Production elected new officers for the 1959-1960 term in Los Angeles recently. Left to right: Mrs. Elsie Edministon, API secretary; C. R. Ball, Ball & Black Supply Co., treasurer; H. H. Ewing, Union Oil Co., of California, district chairman; Paul Hamann, E. B. Hall & Co., vice chairman, Los Angeles Basin; Don J. Evritts, The Ohio Oil Co., vice chairman, San Joaquin Valley; Kenneth Nugent, McCullough Tool Co., vice chairman, Coast Area; O. A. Graybeal, Sunray Mid-Continent Oil Co., vice chairman, Advisory Committee; C. F. Gates, General Petroleum Corporation, chairman, Advisory Committee; Leon E. Matthews, The Republic Supply Co., vice chairman, Coalinga-Kettleman.

rent president of the society. Hall, who is president of General Geophysical Co., will take office November 9 during the society's 29th International meeting in Los Angeles.

Other officers elected are: Frank Searcy, assistant manager of Continental Oil Co.'s geophysical section, Ponca City, Okla., first vice president; Dean Walling, president of Western Geohpysical Co. of America, Los Angeles, vice president; Phil P. Gaby, partner in Delta Exploration Co., Jackson, Miss., secretary-treasurer, and Nelson C. Steenland, partner in Geophysical Associates International, Houston, editor. Dr. Steenland will serve a two-year term, McCollum said.

Intermountain Geologists Plan Annual Field Trip Sept. 10-12

The Intermountain Association of Petroleum Geologists will hold its Tenth Annual Field Conference September 10-12. This year's field trip begins at Provo, Utah. Areas covered will include the Wasatch Mountains, the western end of the Uinta Basin, Uinta mountains and the western edge of the Green River Basin. Fifteen significant wildcats have been drilled in the area to be covered.

Field registration is scheduled from 2 p.m. to 8 p.m. September 9 at the Roberts Hotel in Provo. The trip will end near Evanston, Wyo.

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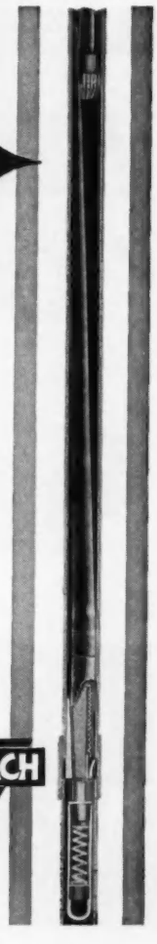
You set your Kinzbach Whipstock at desired depth and position with absolute confidence of positive grip. Trigger assures that whipstock will be set so window will always be in only one joint of pipe. Concave section pivots on one direction hinge above slip section so upper lip always lies against pipe for safe passage of working tools; cannot be hinged into obstructing position.

Whipstock safely, where you want to, and in proper direction with Kinzbach Whipstocks. Available in all popular casing sizes.



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Now with NYLON rings
for 1-1/4, 1-1/2, 1-3/4 and 2" insert pumps and 1-25/32" common working barrels.

- **INCREASE PRODUCTION**
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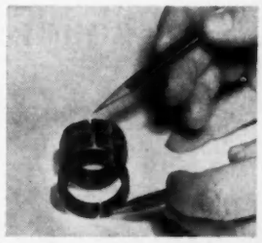

Flex-Seal ring is actually two-rings-in-one. They have been separated here to show split construction as a mated pair.

Assembled Flex-Seal ring shows patented, offset bevels which permit flushing of gas and sand during the free stroke of the plunger or barrel.

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SPEED UP YOUR DEEP HOLE CASING JOBS WHILE PROTECTING YOUR PIPE AND MEN . . . WRITE FOR FREE BROCHURE NOW!

FIVE MODELS TO CHOOSE FROM		
Model	Size Range	Torque Range
54	2 3/8" to 7"	to 9,000 ft. lbs.
55	4 1/2" to 13 3/8"	to 15,000 ft. lbs.
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Joe Perry ..... Salem, Illinois
T. C. McDonald ..... Shreveport, La.
Leidecker Tool Co. Ltd. .. Edmonton, Alberta, Canada
Langley Y Cia. Srl. ..... Buenos Aires, Argentina
East-West Oil Tools C. A. Maracaibo & Anaco, Venezuela
Rooks Oilfield & Engr. Supply Ltd. San Fernando, Trinidad, T.W.I.

What's Happening among SERVICE and SUPPLY MEN

John W. Rife

Web Wilson Oil Tools, Inc., has announced the appointment of **John W. Rife** as general manager. Rife joined Web Wilson 14 years ago. In 1950 he became secretary-treasurer. In 1954 he was elected to the board of directors; and last year he was named assistant to the president.

Schlumberger Well Surveying Corporation has announced changes in two important positions in the corporation. **Everett F. Stratton, formerly** vice president, Operations, has been elevated to executive vice president, and **Charles K. Ruddick,** formerly Southeast Area manager at New Orleans, replaces Stratton as vice president, Operations.

Charles B. (Chuck) Caldwell has been named division manager of the West Texas Area for the **Reed Roller Bit Company.** Caldwell succeeds **Steve Hazlip.** Reed's West Texas Division headquarters are located in Odessa, Texas.

Daniel Orifice Fitting Company has announced that **Herbert H. Hodgeman,** a Texas registered professional engineer, has joined that firm as valve design engineer.

J. J. Dunn has been appointed manager of export sales in the Marketing Department of **Johnston Testers, Inc.** Dunn will make his offices in the Bank of the Southwest Building, Houston.

Electrodynamic Instrument Corporation has named **Charles E. (Pete) Caldwell** systems sale manager. Caldwell will be in complete charge of the company's sales of seismic data reduction systems, magnetic recording equipment and custom instrumentation systems.

Louis E. Magne has been promoted from **Schlumberger Well Surveying Corporation's Southwest Area manager** in Houston to vice president of Operations of **Societe de Prospection Electrique** in Paris, France. **Alan Morazzani,** formerly Rocky Mountain Area manager in Denver, replaces Magne in Houston. **W. R. (Bill) Mills replaces** Morazzani in Denver. **L. C. Chappel** is now division manager of the Oklahoma Division in Oklahoma City. **J. L. Heath** has been assigned as assistant manager of the Mid-Continent Area in Tulsa.

United States Steel Corporation has announced the following appointments: in the **Oil Well Supply Division, Amos L. Savoy,** store manager, Eunice, La.; **Oscar W. Mykleby** as field representative at Houma, La.; **Joe H. Fearn,** field representative, Greensburg, Ky.; **Clair Hass,** store manager Ft. Morgan, Colo.; **Lail Hamilton Shaw** as assistant district engineer, Houston; **Earl L. Maher,** district representative at Gladwin, Mich.; **Joseph C. King,** field representative, Laurel, Miss.; **Woodrow Smith,** field representative, Houston; **Charles O. Damron, Jr.,** store manager, Williston, N. D.; **R. C. Craig,** district manager, Denver; **Paul E. Shea,** field representative, Ft. Morgan, Colo.; and **John W. Todd, Jr.,** assistant vice president, sales-distribution for U. S. Steel's **Tennessee Coal & Iron Division.**

•

Otis Engineering Corporation, Dallas, has announced the appointment of **Carl W. Zimmerman** as manager of the electrical engineering division in the Research and Development Department of the company.

•

Tuboscope Company has announced the promotion of **Bill E. Thomas** to sales manager of the company. Thomas formerly was district manager in Houston.

THESE IMPORTANT POINTS.....

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TUBING BLOCK

1 Flame hardened alloy steel sheaves, extra metal around base of grooves, in wear area.

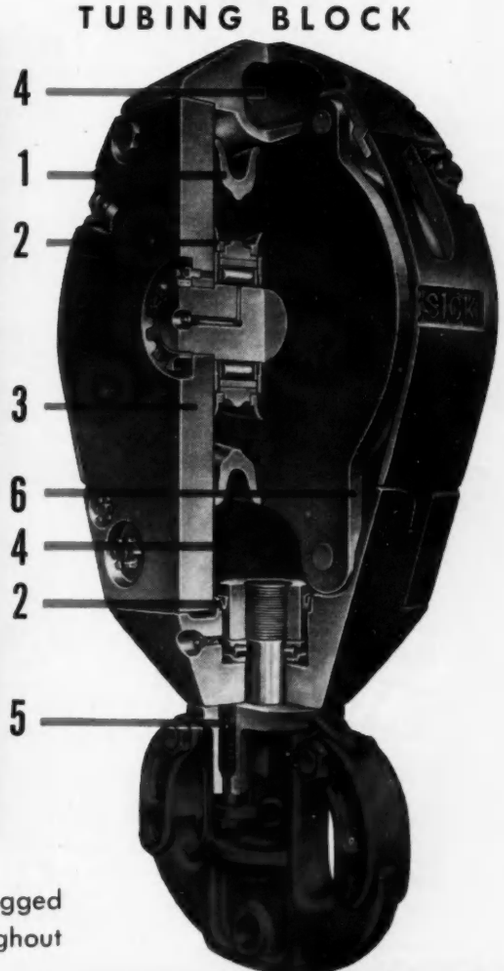
2 Bearings sealed against foreign matter, retaining grease in bearing cavities.

3 Extra heavy steel plates—fast true falls, all pins recessed—smooth streamlined exterior.

4 Clearance for all stringing up links.

5 Simplified locking mechanism—only three parts.

6 Center plates between each sheave strengthen entire structure and eliminates center pin deflection.



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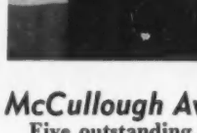
McCullough Awards Scholarships

Five outstanding petroleum engineering students at the University of Alberta, Edmonton, Canada, received scholarships from the McCullough Tool Company. Selected by staff members of the university's Chemical and Petroleum Department, the five students were chosen on the basis of academic standing, financial need, and participation in extra-curricular activities. Norman Brookes, center, Canadian division manager of McCullough Tool Cmpany is shown with D. L. Flock, associate professor of petroleum engineering, University of Alberta. Extreme right, Dr. G. W. Govier, head of the University's department of chemical and petroleum engineering. In the background are the five students who received the scholarship awards. Left to right: R. J. Russell, P. P. Kovacs, G. R. Scott, R. A. Mackett and F. C. Greaves.



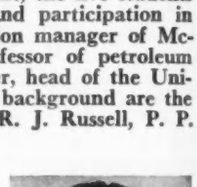
W. D. Owsley

Halliburton Oil Well Cementing Company has added a new director and advanced three other executives. **William D. Owsley,** senior vice president, was elected a director. **Marvin K. Brummett,** secretary, was elected vice president and secretary. **John P. Harbin** was elected financial vice president, a new position. He formerly was controller and assistant secretary. **J. E. Thomson,** chief accountant, was elected controller and assistant secretary.

C. E. Mangold

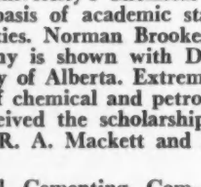
W. N. Estel

C. E. Mangold and **W. N. Estel** have been named assistant general managers of **Dowell Division of The Dow Chemical Company. R. S. Ousterhout,** assistant general sales manager, Tulsa, has transferred to Dallas to supervise the Dallas-Fort Worth sales offices. It has also been announced that **Howard Waugh** has been transferred from Dowell's Calgary, Alta., office to Charleston, W. Va.



R. S. Ousterhout

L. J. Stansell has been promoted to manager of the Kansas-Oklahoma area for **Johnston Testers, Inc.** Stansell was formerly assistant manager of the area. His territory includes North Texas and the Texas Panhandle in addition to Kansas and Oklahoma.



L. J. Stansell

U.S. Steel's Oil Well Supply Division has announced the following appointments: **R. L. Armstrong,** pioneer Wyoming oil man, will take over a top overseas management post. He has become director of Oil Well Supply, Ltd., with offices in London. **Warner D. Thamm** was appointed field representative at Victoria, Texas; **Joseph Roscoe Nye** as store manager at Pampa, Texas; **Guy A. Lewis** as assistant district engineer, Machinery and Equipment Sales and Service at Los Angeles.

Frank Semper has recently joined the **Reed Roller Bit Company** sales organization and will assume his duties as special representative in Bahia, Brazil. He will work with Red Special Sales Representative **Vladimir Edelberg** of Buenos Aires.

Garrett Oil Tool, Division of U.S. Industries, Inc., has announced the appointment of two new agents to handle the sales of Garrett valves and other industrial and pipe line equipment. **MechanEquip, Inc.,** Dallas, will handle Garrett equipment in North Central Texas; **Bass Industrial Equipment Company,** Buffalo, N.Y., is the new Garrett agent for western New York.

Jerry O. Price

Jerry O. Price has rejoined **The Brewster Company,** it has been announced. Price formerly served as a key Brewster sales representative for nine years. During the past year he was with Associated Oil Field Rentals in New Orleans and Lafayette, La.

Jeddy D. Nixon, Jr., has recently been appointed Western Division manager for **Servicos Hydrocarb,** C. A. in Venezuela. He will make his headquarters in Maracaibo.

I. B. Allen

I. B. Allen has been appointed representative in Trinidad, B.-I.W., for the **Rolo Manufacturing Company.** Allen recently expanded his activities by acquiring the services of **G. J. Streetly,** who will assist him in Trinidad as well as in Venezuela.

George B. Coale

George B. Coale, general manager of **Baroid Division National Lead Company,** has been elected to the board of directors of **National Lead Company.** Coale also is a vice president of National Lead and has been general manager of Baroid Division since 1954.

Rolo Manufacturing Company has announced the promotions of **V. E. (Bob) Smith** to sales manager; **P. A. Clewer** to assistant sales manager and **J. L. Kepple** to assistant to the president.

Robert E. Dunn

Robert E. Dunn has been promoted to the post of assistant to the general manager of sales for **Cardwell Manufacturing Company.** Dunn has been merchandising manager for the company since 1958. Prior to joining Cardwell, Dunn was associated with Mid-Continent Supply Company in various capacities.

Franks Division of Cabot Shops, Inc., has announced that **Ralph Dicus** has joined their organization as a sales representative working out of Oklahoma City.

Lester Farley has joined the **Tyson Smith Company** as a sales engineer and will cover the San Antonio, Victoria, and surrounding areas from the Corpus Christi, Texas, sales office.

Ernest Holy

Sidney A. Adger

Ernest Holy, administrative vice president, and **Sidney A. Adger,** vice president of Public Relations and Sales, **Milwhite Mud Sales Company,** were recently elected to that company's board of directors.

Oil Well Supply Company recently named **R. L. Armstrong,** formerly Rocky Mountain area manager, to director of Oil Well Supply Co. Ltd., with offices in London. Replacing Armstrong at Casper, Wyo., is **A. S. Finefrock.**

L. C. Rowe, formerly corporate secretary for **Rockwell Manufacturing Co.,** Pittsburgh, has been named director of a new department, Governmental Relations.

J. K. Meagher has been transferred from Dallas to Houston as sales representative in the Lower Texas Gulf Coast area for **Baroid Division National Lead Company.** Replacing Meagher as sales representative in Dallas is **N. S. Wood,** previously with Baroid in Calgary, Alta.

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. . . if your well is equipped with a JENSEN Rotary JACK.

The deeper your well, the more important counterbalance becomes.

Improper balance can cause unnecessary damage and costly downtime.

But JENSEN Rotary JACKS anticipate deep well problems; they can be adjusted in minutes by just one man—standing on the ground.

For both shallow and deep wells, insist on efficient, low-cost JENSEN Rotary JACKS.

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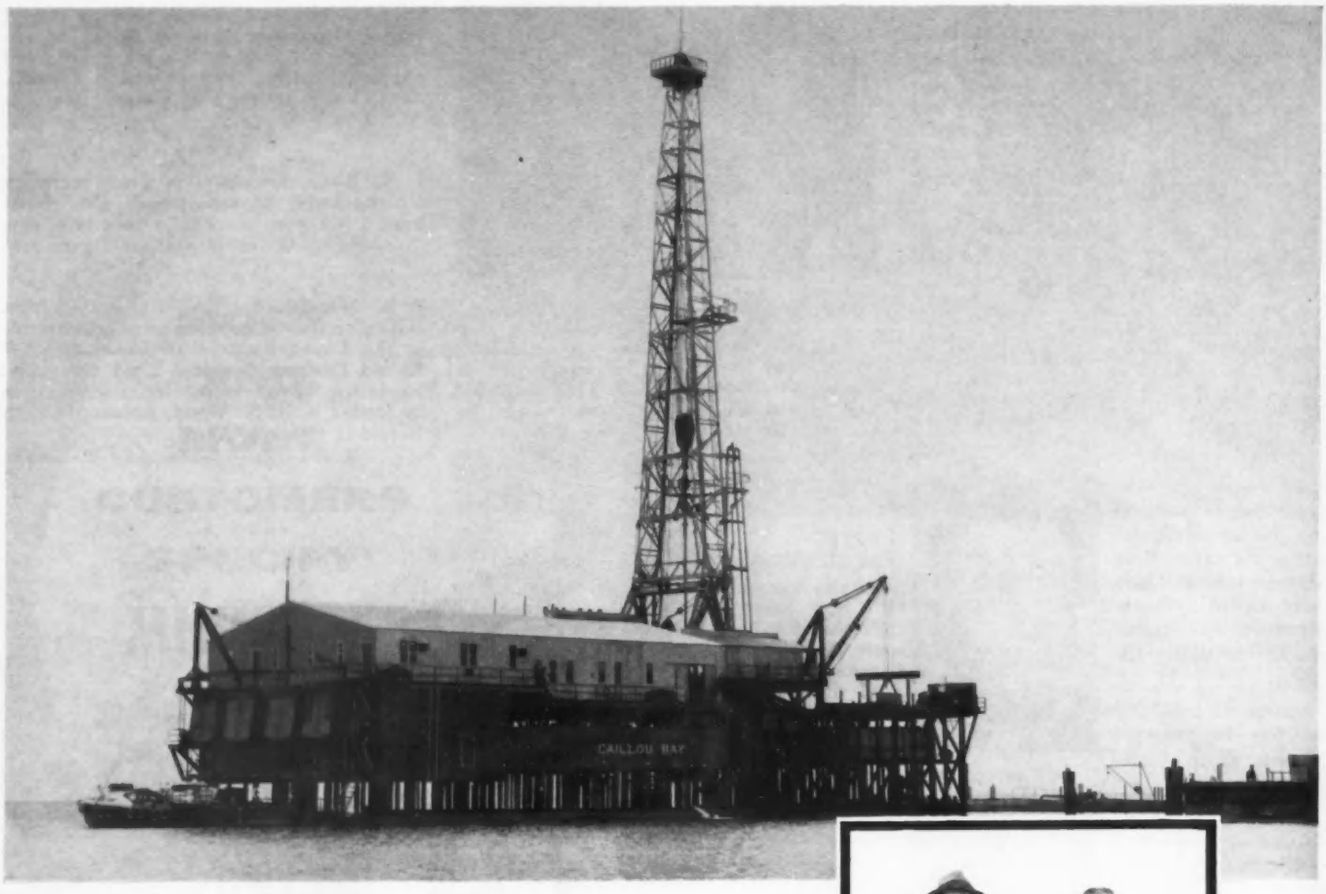
JENSEN JACKS



"They meet production schedules at AVONDALE",

says Mr. Sid Brewster—Chairman of Board—Brewster-Bartle Drilling Company, Houston.

"Time is money in the oil drilling business. Everything we do is tied in with a rigid schedule that must be met. We know from past experience that they meet production schedules at Avondale. That's one of the big reasons we awarded them the contract to build our new drill barge."

Left — Mr. Vernon Grimes, Drilling Superintendent, is shown with Mr. Brewster. Mr. John Domercq is President of Brewster - Bartle Offshore Company.

The Brewster-Bartle Offshore Company drill barge referred to and pictured above has hull dimensions of 200' x 54' x 10', post type with intermediate level 10 feet above barge deck, for drilling in depths up to 16 feet. Complete living quarters provided for crew. *Time of completion: Seventy (70) working days.*

Need Drill Barges in a hurry? Call Avondale.

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The Youngstown Sheet and Tube Company has announced that **Leo DeFiore** has been appointed director of engineering and **Carl J. Lucas** has been appointed chief engineer.

Otis Engineering Corporation of Dallas has announced the appointment of **Turner G. Garwood** as the company's sales representative for Europe, Africa, and the Middle East. He will make his headquarters in Geneva, Switzerland.

Turner G. Garwood

HOMCO has announced the election of **C. L. (Hal) Roach** as vice president in charge of all domestic operations. Also, **John N. Donhaiser** has joined the firm as coordinator of Research and Development. HOMCO, also announced the appointment of the following personnel as division managers: **Warren Hollier,** Rocky Mountain Division, headquartering in Casper, Wyo.; **Gene Webb,** Eastern Louisiana and Mississippi Division, with offices in New Orleans; **E. C. Alford,** Western Louisiana Division, in Lafayete, La.; **R. M. (Wimpy) Freeman,** South Texas Division; **C. J. Erwin,** West Texas and New Mexico Division, at Odessa, Texas; **Don Burton,** North Central Division, in Oklahoma City.

C. L. (Hal) Roach

J. E. (Ed) Giles has been appointed Oklahoma division sales manager for **W. C. Norris, Manufacturer, Division of Dover Corporation,** with headquarters in Tulsa. At the same time it was announced that **Joel Little** and **Ed Scholl** were added to the sales force. Little has been assigned to the Oklahoma City office and Scholl has been assigned to the Southern Oklahoma territory with offices in Ardmore.

Halliburton Oil Well Cementing Co. Purchases Otis Engineering Company

Otis Engineering Company has become a subsidiary of Halliburton Oil Well Cementing Company. Directors of both firms completed stock transfer in mid-July, and Halliburton elected H. C. Otis, founder and chairman, to its board of directors.

No changes are contemplated in Otis' present operations and policies, according to the announcement. All employes and officers are remaining with the new company.

Rogers Geophysical Affiliate Opens Branch Office in Spain

A new branch of Geoficia Rogers, C.A., an affiliate of the Rogers Geophysical Company, has opened in Madrid, Spain. The new facility offers complete geophysical services for oil operators in Spain and its possessions under the managership of Lewis F. Judson. Headquarters are in the Castellana Hilton Hotel.

Other Rogers offices, in addition to Houston, are maintained in Caracas, Venezuela; Mogadiscio, Somalia; Paris and London.

Wilson Supply Company Now Boasts 21 Stores

Wilson Supply Company now has 21 store points serving the oil industry with its recent acquisition of Fort Stockton Pipe & Supply Co., Fort Stockton, Texas. It has been announced that William Sallee will manage the Fort Stockton operation for the company.

Technical assistance on gas compressors and drilling machinery will be offered through this new store. Wilson also has West Texas stores at Odessa, Monahans, Post and Hobbs, N. M.

Chiksan Company Acquires Hamer Valves, Incorporated

Purchase of the business and properties of Hamer Valves, Inc., by Chiksan Company was recently announced jointly by L. S. Hamer, founder and president of Hamer Valves, Inc., and H. J. Hagn, president of Chiksan Company. Completion of the transaction was subject to final closing early in July.

According to officials of both companies, the transaction will benefit Chiksan in rounding out its product lines in the petroleum and chemical industries, and will provide Hamer Valves with a broader marketing organization.

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TUBING JOINTS THAT SEAL TWO WAYS
with Metal-to-Metal Seal and a Compressed Soft Seal
Dual-Seal tubing connections* by Hardy-Griffin are the first field proved and accepted new design in over ten years.
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Check these other features:
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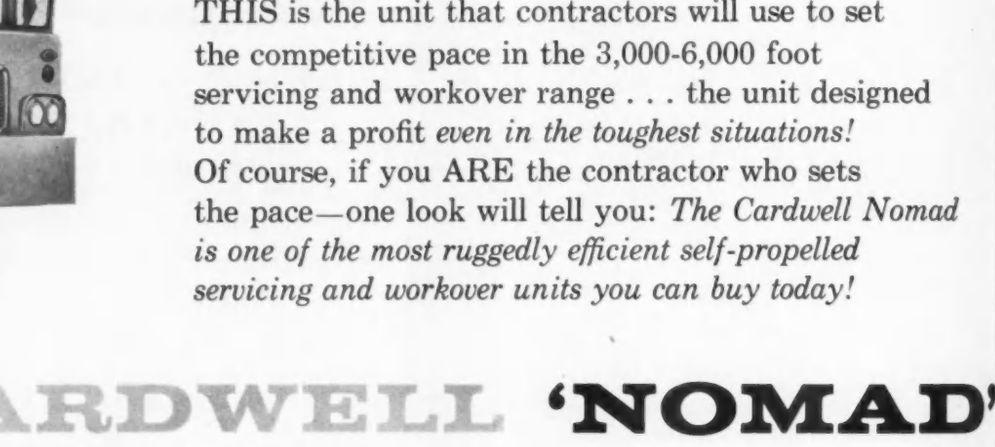
Set the Pace!

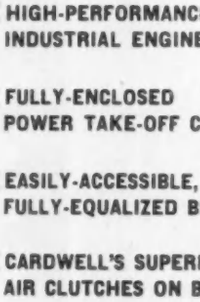
If you don't own one—better take a *good* look at The Cardwell Nomad! ***This is your competition!*** THIS is the unit that contractors will use to set the competitive pace in the 3,000-6,000 foot servicing and workover range . . . the unit designed to make a profit *even in the toughest situations!* Of course, if you ARE the contractor who sets the pace—one look will tell you: *The Cardwell Nomad is one of the most ruggedly efficient self-propelled servicing and workover units you can buy today!*

THE CARDWELL 'NOMAD'

NO OTHER UNIT OFFERS ALL THESE:

- **CARDWELL'S BIG TIME-PROVED HOIST!**
- **HIGH-PERFORMANCE INDUSTRIAL ENGINE!**
- **FULLY-ENCLOSED POWER TAKE-OFF CHAIN DRIVE!**
- **EASILY-ACCESSIBLE, FULLY-EQUALIZED BRAKES!**
- **CARDWELL'S SUPERIOR "FLEX-DISC" AIR CLUTCHES ON BOTH DRUMS!**
- **OPTIONAL HOIST CONTROL POSITIONS!**





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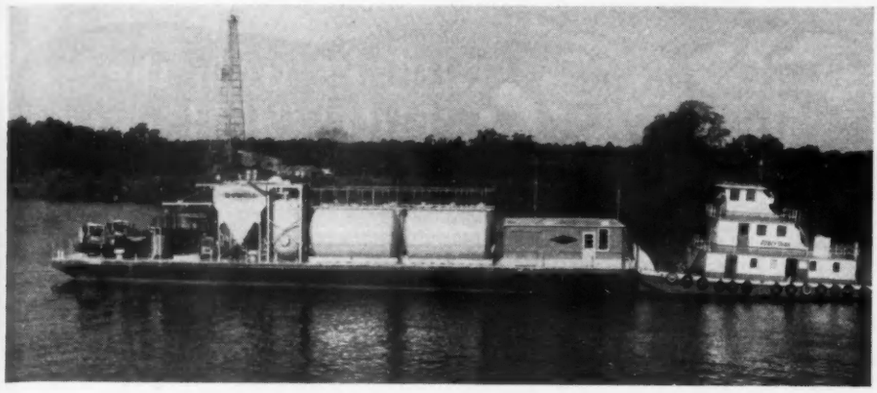


One of two new service barges shown at Dowell open house.

Ruska Instrument Corporation Completes New Building

Ruska Instrument Corporation, Houston, has announced the completion of a combination office, laboratory and manufacturing building in the Sharpstown Industrial Park.

The new building contains 13,500 square feet of floor space, about a fourth devoted to administrative offices. Laboratories for research, development and testing are housed in the center of the one-story structure and the balance of space is devoted to instrument shops, machine shops and areas for assembly and finishing.

Officers of the company are Walter Ruska, president; C. D. Warner, vice president; S. H. Buckley, vice president, and M. M. Lignoul, secretary-treasurer. William H. Breihan is the general sales manager.

Dowell Unveils Two New Barges To Serve Louisiana Gulf Coast

The Dowell Division of The Dow Chemical Co. unveiled two new service barges at an open house last month in New Orleans. The new barges will provide cementing and pumping services for operators in the Terrebonne and Timbalier Bay areas on the Louisiana Gulf Coast.

The barges, built by McDermott Fabricators, are each 120 feet long and 30 feet wide. Both are equipped with a complete cementing station, including four bulk cement storage tanks, each with a 1,000 cubic foot capacity.

Other features include the latest type air slides and pumps for handling dry cement, Dowell-designed densitometers and a 2,000-gallon acid storage tank on each barge. Dowell-designed 4½ by 8-inch triplex pumps are standard equipment on both barges. Leased tugs will be used to move the barges. A third barge, now under construction, will be used only to transport bulk cement.

Perforating Guns Atlas Corp. Renamed Pan Geo Atlas Corp.

The stockholders of Perforating Guns Atlas Corporation of Houston have authorized a change of the company's corporate name to Pan Geo Atlas Corp. effective immediately.

Pan Geo Atlas Corp. continues as a subsidiary of Chemetron Corporation, a company with international and widely diversified industrial operations. The general offices and plant of Pan Geo Atlas Corp. are in Houston, from where operations of its more than 45 branches and four subsidiaries are directed.

Continential-Emsco Co. Opens Three California Supply Stores

Continental-Emsco Company, a Division of The Youngstown Sheet and Tube Company, has announced the recent opening of three new supply stores in California. The stores, located in Bakersfield, Ventura and Los Angeles, will be completely integrated supply facilities servicing the needs of the drilling and production operations in California.

Maloney-Crawford Purchases Entire Union Tank Division

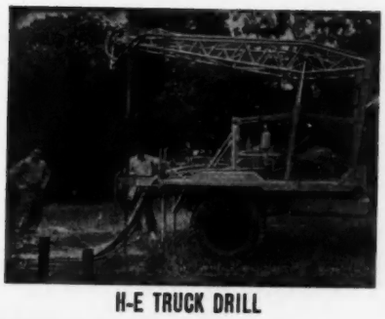
The Maloney-Crawford Tank and Manufacturing Company has purchased the entire Union Tank Division, Houston, of Butler Manufacturing Company, Kansas City, Mo.

Butler will retain the Houston plant for the manufacturing of metal buildings and other products and, for a limited period, will continue to manufacture products for Maloney-Crawford.

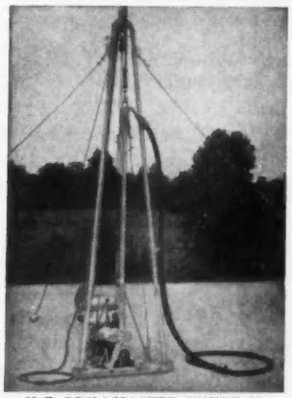
GEOPHYSICAL EQUIPMENT

H-E TRACTOR DRILLMASTER

H-E manufacture a wide range of Geophysical supplies in addition to that illustrated including: loading poles, cable reels, winches, shooting trucks etc. Write for full details quoting ref.D/GL.



H-E TRUCK DRILL



H-E DRILLMASTER MINOR II

H-E RECORDING CAB

H-E BREAST REEL

H-E WATER TRUCK

HANDS - ENGLAND OILFIELD EQUIPMENT LTD

MANUFACTURERS OF GEOPHYSICAL SUPPLIES

LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND

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CAPITOL

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for all high pressure installations

Both 3000# and 6000# couplings are manufactured to ASTM Specification A-105.

Available in full and half couplings for immediate shipment from stock in sizes:
3000# — ⅛" through 4"
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COUPLINGS — NIPPLES — UNIONS — RADIANT HEAT FITTINGS — FURNACE COILS — WELL SUPPLIES — STEEL PIPE FITTINGS

Well Versed

When the attractive young lady, filing her application for overseas duty with the Red Cross, came to the question asking if she were prepared for services overseas, she wrote, "I can say 'No' in 10 languages."

The Prescribed Cure

Dr. Baldy, after examining the elderly patient, jokingly observed, "You're in pretty good shape but I'd suggest you give up half your love life."

Elderly patient: "Which half? Talking about it, or thinking about it?"

Musical Investment

St. Peter: "And here is your golden harp."

Newly-arrived guest: "How much is the first payment?"

The Prosecution Rests

If it's true that women can be judged by the clothes they wear, some of 'em would have to be dismissed for the insufficient evidence.

A Swell Looker

"She looks like a million dollars."

"Yeah, and she walks like it was all in loose change."

Oh, to End It All

One fellow in town I know is always trying to drown his troubles, but he can never get his wife to go swimming.

Sorry, Business Hours

Customer: "Do you have any notions on this floor?"

Floorwalker: "Oh yes, madam, but we try to suppress them during working hours."

It Pays to Advertise

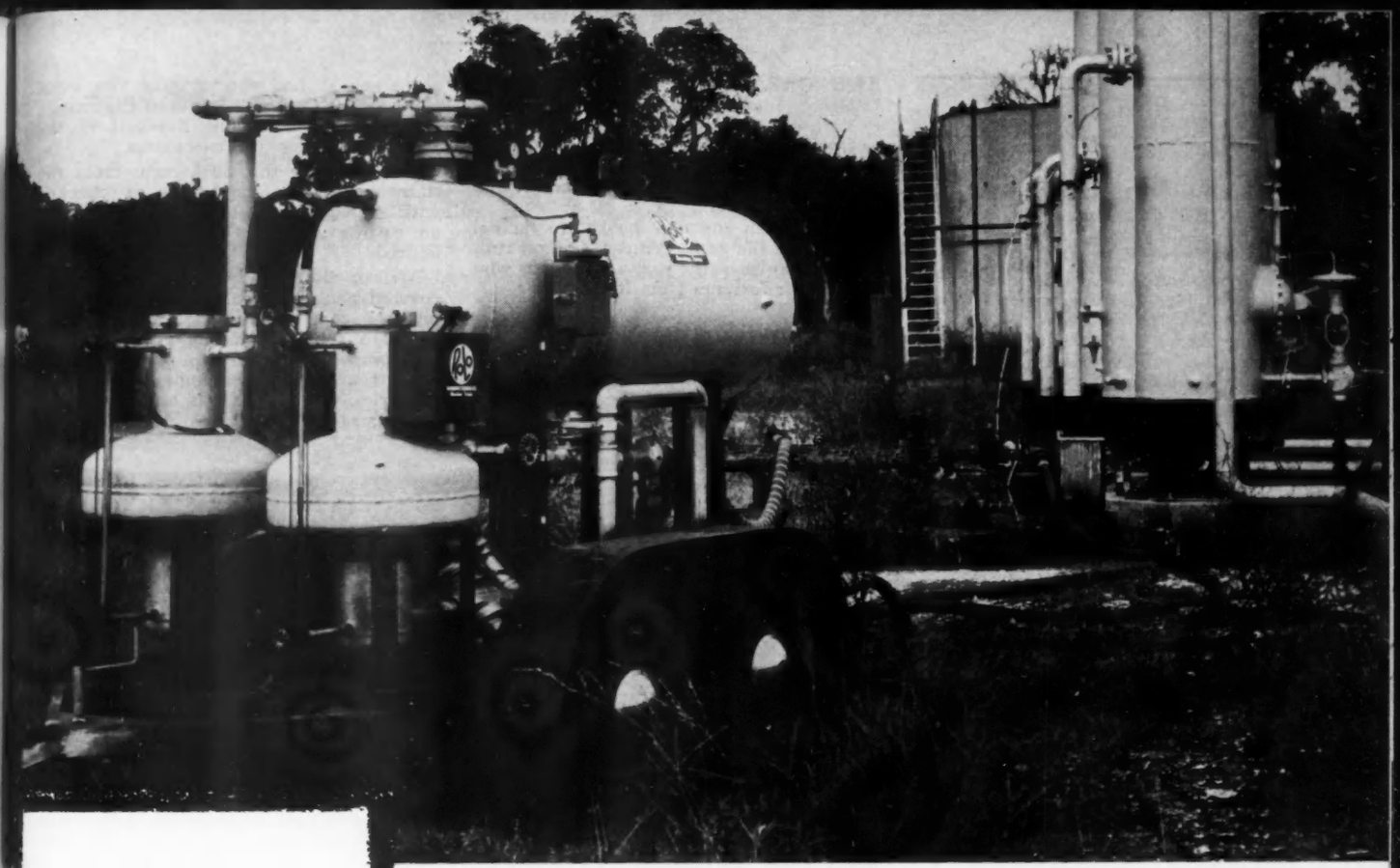
Advertisement by a young psychiatrist: "Satisfaction guaranteed or your mania back."

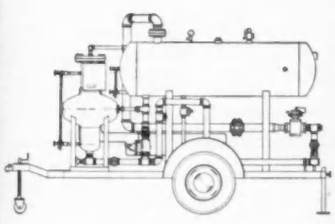
Ah, Spring

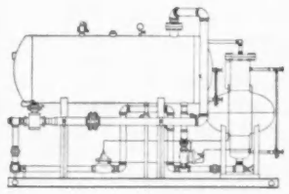
The gentleman was gazing rapturously at "Spring," a large oil painting of a shapely girl dressed only in a few strategically arranged leaves. Suddenly the voice of his wife snapped, "Well, what are you waiting for—autumn?"

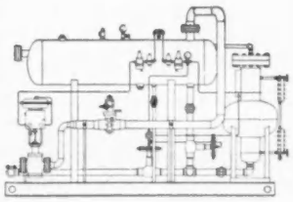
To Agree or To Disagree

A top TV executive revealed the absolute fairness of his boss. At a meeting one day, the executive put several ideas before his staff. "All of you who find yourselves in disagreement with the suggestions I've made," he announced, "will please signify by saying, 'I resign'."









Here's a form of AUTOMATION every field can afford . . .

Rolo Wellcheckers provide limited automation in fields where existing facilities and small production do not justify complete, automatic sequence well test systems.

These packaged units incorporate everything necessary for accurate, metered well tests: test separators, dump-type oil meters and gas metering facilities. Accessories include free water knockouts, dump-type water meters, and Rolo Automatic Samplers for determining water and sediment cut.

All functions are automatic; just switch the well into the Wellchecker, and it automatically separates and meters the oil, water and gas production. The pumper has only to read meters at the end of the test. There's even a Production Time Recorder available to chart production versus time, making attendance at the end of the test period unnecessary. These automatic features give you *more* tests per month and make it easy to meet well-testing schedules.

Wellcheckers are available trailer mounted or skid mounted. Portable Wellcheckers are easily transported for tests at the wellhead. Both permanent and portable units serve at central stations so that wells can be switched through them. Wellcheckers are invaluable in making drillstem tests, too.

Metering is the heart of production automation systems . . . Rolo Wellcheckers offer limited automation on a quick-payout basis, by:

- **freeing test tanks for additional storage facilities**
- **freeing pumpers from testing chores**
- **allowing more tests per month**
- **assuring maximum accuracy in well test measurements**

BETHLEHEM STEEL

In the U. S., contact your nearest Bethlehem representative for information and prices on Rolo products. In Canada and for export, see below.

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ROLO MANUFACTURING COMPANY
P. O. Box 22126, Houston 27, Texas
Canada: Petro-Automation Industries, Ltd., Edmonton, Calgary and Regina
Export: R. S. Stokvis & Sons, New York, N. Y.

BOOKS

COVERED WAGON GEOLOGIST, The University of Oklahoma Press, The University of Oklahoma, Norman, Okla., Charles N. Gould, $4.00.

The manuscript autobiography of Charles N. Gould, distinguished for his professional career which spanned 60 years of pioneering in the geology and paleontology of the Southwest. He was not only a scientist but a teacher, consultant, public servant, and benefactor of many.

THE GREAT OILDORADO, Random House, Inc., 457 Madison Avenue, New York 22, N. Y., Hilegarde Dolson, $3.95.

In the form of a novel, The Great Oildorado tells the story of the lusty years of America's first oil rush in Pennsylvania during 1859-1880.

Included in the new book, are factual accounts of the great Pennsylvania oil rush and the stories of the early Americans who made their fortunes from it.

THE OIL DIRECTORY OF TEXAS, 1959, R. W. Byram & Company, Drawer M, Capitol Station, Austin, Texas, $15.

The Oil Directory of Texas, 1959, enables you to find the oil man you want right away. This book contains the names, addresses and telephone numbers of the principal officers and executives.

The data for this book come from the state records first and then is checked with each company to give the company an opportunity to make any changes desired.

Within the 355 pages of this slick-covered book are the lists of 6171 Texas oil producers; 2654 Texas gas producers; 165 Texas oil purchasing and transporting companies; 351 Texas gas purchasing and transporting companies; 69 Texas refineries; 210 Texas gasoline plants; 15 Texas carbon black plants; 32 cycling plants; and 129 repressuring plants.

OIL WELL DRILLING TECHNOLOGY, University of Oklahoma Press, Norman, Okla., Arthur W. McCray and Frank W. Cole, University of Oklahoma, $9.95.

Oil Well Drilling Technology presents a thoroughgoing technical discussion of the geological and geophysical principles governing oil accumulation and the drilling of wells from the standpoint of the driller, petroleum engineer, geologist and student.

Practical problems are posed and methods of solving them demonstrated. Graphs, charts and figures are used freely, along with illustrations of many types of equipment, to aid the driller in visualizing the solution of problems. The experienced oil man can find in these pages practical answers to many of his problems and questions, the student a sound text for basic principles of oil well drilling.

OIL WELL DRILLING TECHNOLOGY, University of Oklahoma Press, Norman, Okla., Arthur W. McCray and Frank W. Cole, College of Engineering, University of Oklahoma, $9.95.

Oil Well Drilling Technology, the product of extensive research and practical investigation, complied with the assistance of the American Association of Oilwell Drilling Contractors, is a comprehensive presentation of the procedures identified with this complex subject.

It presents a thorough technical discussion of the geological and geophysical principles governing oil accumulation and the drilling of wells from the standpoint of the driller, petroleum engineer, geologist and student. Practical problems are posed and methods of solving them demonstrated. Graphs, charts and figures are used freely, along with illustrations of many types of equipment, to aid the driller in visualizing the solution of problems.

PETROLEUM REVIEW, COCHRAN AND HOCKLEY COUNTIES, TEXAS, Phifer Petroleum Publications, Houston, Robert L. Phifer, $15.

Compiled from the records and hearing files of the Railroad Commission of Texas, this new book offers a complete history of the 39 fields that have been discovered in the two counties since 1936. Production for each field through 1958 is given by years and cumulatively, listing the number of producing wells. Among the illustrations in the book are 13 subsurface structure maps and 21 logs of discovery wells. There is also a map of two counties with the fields in color. Information throughout is current through March, 1959.

More than 1 million tons of mud have been weighed by Mud-O-Graf. This experience has led to the new, foam-proof, lost circulation-proof model.

A complete cycle of weighing is made every 45 seconds. The weighed sample is completely flushed out and passes over the shaker before the next fresh sample is taken.

The recorder can now be installed on the derrick floor without adverse effects from rig vibration on either its remarkable accuracy or its general operation.

Twenty years of experience in the mud weighing business has proved that there is no substitute for a completely accurate, continuous chart record of mud weight *placed in front of the driller.* Check these features:

- A weighing unit that will handle lost circulation material or foamy mud.
- The sample is taken every 45 seconds directly from the mud stream and is not dependent on pumping to a remote location.
- Each sample is completely flushed.
- The weighing unit is smaller and easier to maintain.
- Continuous recording on a circular chart, where a full twenty-four hours is visible to the driller.
- Recording is easily readable and accurate to 1/2 of 1/10 pound per gallon.

WARREN AUTOMATIC TOOL CO.
3915 THARP STREET • HOUSTON, TEXAS
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What's New in EQUIPMENT and SERVICES

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New Oil Field Vehicle

The Trusty RKN/QR6, a tractor unit with combination-type oil field body and fifth-wheel coupling for semi-trailer, is in use in Argentina. It has a Thornycroft chasis and a Hands-England body. Standard features of the engine insure satisfactory operation in hot, dusty conditions in present day application are the differential cooling system, which has a total coolant capacity of 13 gallons, 8 gallon capacity sump with twin full-flow filters in the pressure lubrication system and a heavy-duty oil-bath cleaner on the air intake. (Transport Equipment [Thornycroft], Limited).

For more data, circle E1 on postcard

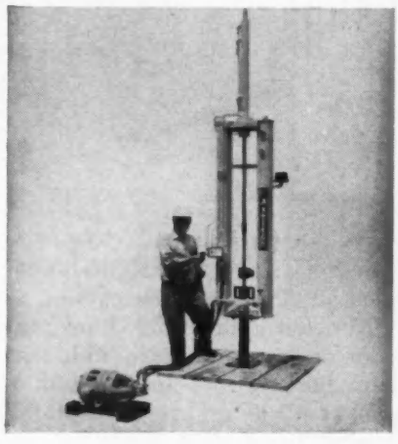
Unrestricted Bit Lube

Bit Lube (T.B. 81-58), which previously was restricted in certain applications, now may be added to any mud system without upsetting the physical properties of the mud. Beneficial results can be expected in fluids containing up to 15 percent oil, according to the manufacturer. It may be used in any area to prevent or minimize premature bit bearing failure, decrease rotating torque and improve drilling rate. (Magnet Cove Barium Corp., a Subsidiary of The Dresser Industries, Supplements data on Pages 3128-3129, 1958-1959 Composite Catalog).

For more data, circle E2 on postcard

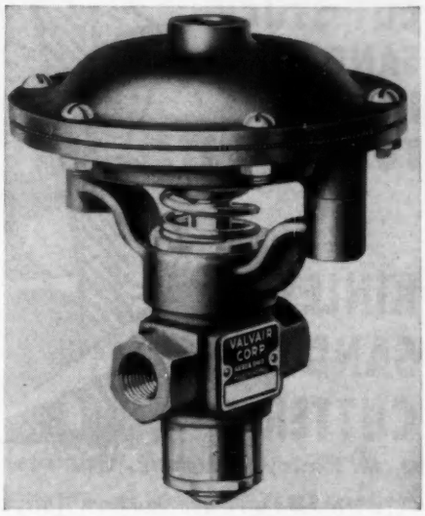
Hydrax Pumping Unit

A modern and unique development in surface pumping equipment for stripping per well application and for usage in the replacement of obsolete Jackline and Longtail installations is now available. Features of the new 24-inch Hydrax pumping unit are a unique pedestal reservoir for efficient



system fluid cooling, magnetic plug to remove any metallic particles in the system, a safety switch which automatically stops the unit in case of emergency and a fluid strainer. (Axelson Manufacturing Co., Division of U.S. Industries Supplements data on Pages 229-264, 1958-1959 Composite Catalog).

For more data, circle E3 on postcard



Diaphragm Control Valve

Designed for actuation by any 3-way pilot valve, instrument control, cycle controller or process timer, this valve is suitable for use in air, oil or vacuum circuits. Features neoprene covered synthetic fabric diaphragms for maximum flexibility and resistance to oil, plus extremely high bursting strength. Corrosion resistance and minimum wear, valve bodies are cast of Navy M. Bronze; stems are hard-chrome plated stainless steel. Minimum pressure drop attributed to flow area through valves. (Valvair Corp.)

For more data, circle E4 on postcard

Anti-Freeze Dump Valve

Newly developed is the Type 125 anti-freeze control valve for use as a liquid dump valve on high pressure oil and gas separators and other processing vessels. Elongated angle style body, designed for vessel adaptation, retards freezing action by absorbing heat from the gases at the top of the vessel. May be operated by instruments such as intermitters, pressure controllers and level controllers. Valve is electric cast steel with pressure rating of 3,000 WOG. (Fisher Governor Company, Supplements data on Pages 1438-1439, 1958-1959 Composite Catalog).

For more data, circle E5 on postcard

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

ABILENE, TEXAS—Hudson-Eads, Inc....OR 2-5331
BAY CITY, TEXAS—J. P. Graham.....CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc....TE 5-7046, ZF 8-2023
CASPER, WYOMING—C. A. White.....3-5264
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5389
HOUMA, LOUISIANA
Assoc. Eng. & Equip. Co.....UP 2-0347
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc.....5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqt., Inc.....CE 5-6770
LAUREL, MISSISSIPPI
Assoc. Eng. & Equip. Co.....8-7588
LIBERAL, KANSAS
Rainbo Service.....Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co.....PL 6-2530
MIDLAND, TEXAS
Luscous Service & Eqpt. Co.....MU 2-1631
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0108
VIDALIA, LOUISIANA
Davis-Kemp Tool Co., Inc.....438
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2781
WICHITA FALLS, TEXAS
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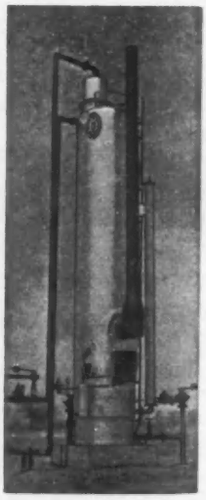
OPERATING ECONOMY



MFD BY M&V TANK COMPANY WICHITA FALLS TEXAS

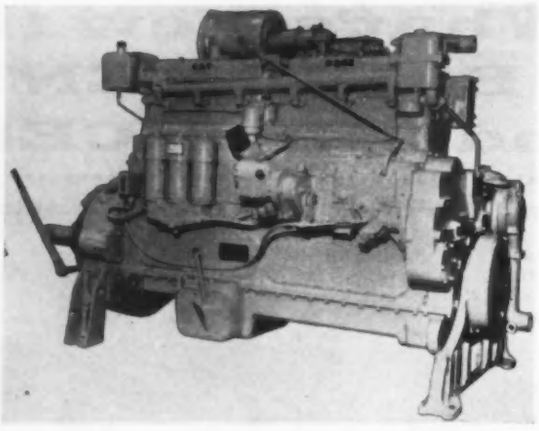
Type P-V Pressure Treaters

M & V TANK COMPANY

Wichita Falls, Texas

TANKS – TREATERS SEPARATORS

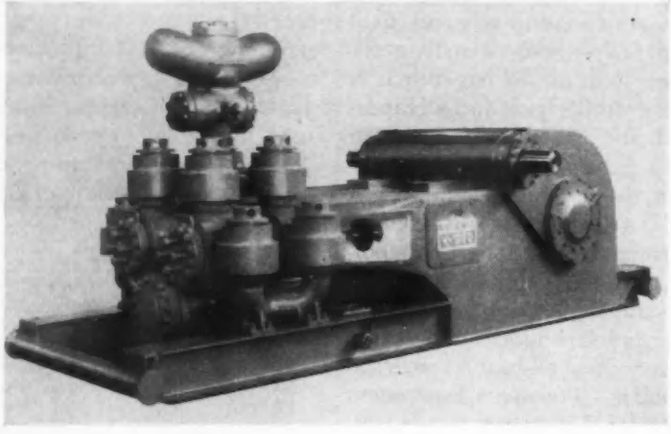
Steel Fabrication for the Oil Industry



New Gas Engine

A new, spark-ignited engine, designed to operate on a wide variety of gaseous fuels, is available. The D342 Series C spark-ignition engine takes its place alongside the D397 and D375. By changing pistons and fuel systems, it can be converted to diesel operation, and likewise, can be converted to gas operation. Two compression ratios available—10:1 for high efficiency operation with methane type gases and 7.5:1 with liquefied petroleum or field gases. (Caterpillar Tractor Co. Supplements data on Pages 1240-1243, 1958-1959 Composite Catalog).

For more data, circle E6 on postcard



New Slush Pump

National's new H-1250 slush pump, rated at 1,250 input horsepower, will deliver 780 gpm at 2,335 psi maximum discharge pressure with maximum bore of 7¾ inches, and 440 gpm at 4,135 psi with 6-inch liner, at rated speed of 65 strokes per minute. Stroke length is 16 inches. Liner packing gives long and trouble-free service because it is never subjected to pressure greater than that which it must seal and because sealed clearances are accurately controlled and remain constant. (The National Supply Co. Supplements data on Pages 3549-3668, 1958-1959 Composite Catalog).

For more data, circle E7 on postcard

New Perforator

Introduction of the new "Atlas-Jet," reported to be an exceptionally effective shaped charge recently developed for conventional steel case retrievable 4 and 5-inch jet gun, has been announced. This charge delivers superior performance in all important factors governing perforator evaluation, according to the manufacturer. The weight of the explosive in the charge has not been increased over that used in conventional-type shaped charges. (Perforating Guns Atlas Corporation. Supplements data on Pages 4089-4112, 1958-1959 Composite Catalog.)

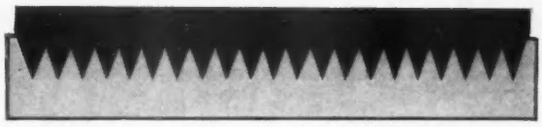
For more data, circle E8 on postcard

Service . . .

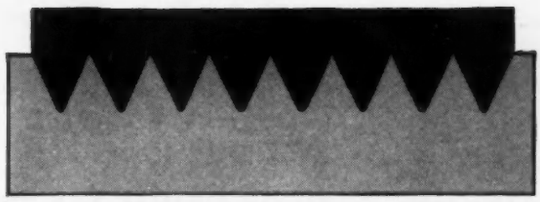
wide range of special drive designs . . .

provide for more power in less space

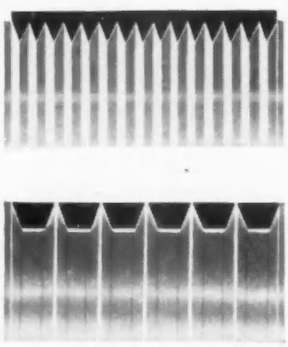
Now from one source, Dayton Industrial Products Company—the most complete line of friction-type drives in existence—for every application from automatic washers and dryers to large industrial machinery and farm implements.



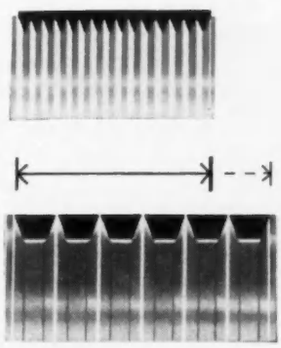
Gives Greater Power Capacity. Full contact with the entire sheave driving surface gives Dayton Poly-V greater power capacity because it has twice the contact area of other drives with half the surface pressure.



Maintains Constant Pitch Diameter at All Loads. Full contact of Dayton Poly-V gives solid support under strength member. Speed ratio doesn't vary. Belt position remains constant from no load to full load.



Delivers More Power. Dayton Poly-V increases the drive capacity 30% to 50% in the same drive width . . . functions as a friction-force-multiplier in the sheave groove. Makes Poly-V ideal where more compact design is essential. Three cross-sections (J 3/32", L 3/16", M 3/8" rib widths) handle all applications.



Saves Space. Narrower drives deliver equal power in less space. In most applications, the width of Dayton Poly-V Drive is 2/3 to 3/4 of the width of standard multiple drives of the same horsepower. Poly-V has higher horsepower capacity per inch of sheave width. Means less shaft overhang, less drive weight, lower drive cost.

DAYTON'S SPECIAL ENGINEERING SERVICE

Make use of Dayton's special Drive Engineering Service when you think of power transmission. The time to call us is when your design is still on the drawing board. We have *no axe to grind* —we'll help you select the Dayton V-Belt Drive (FHP, Multiple Variable Speed or Poly-V) best suited to your specific need.

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Dayton Industrial Products Co.

Melrose Park, Ill. *A Division of The Dayton Rubber Company*

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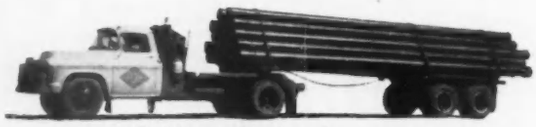
Congrats and $25 for this quip to M. H. Barber, Continental Oil Co., Big Spring, Texas.

"told him to pack the pump"

Whether it's running casing for surface hole, intermediate string, oil string or tubing . . . Lone Star Steel pipe is the brand Joe Roughneck counts on. Centrally located in the heart of the Mid-Continent oil producing area, Lone Star delivers API electric-weld casing, tubing and line-pipe on the double . . . in quantity! And, you can depend on Lone Star for quality as well as quantity. Our ultra-modern steel mill is equipped with the newest, most efficient tools in the industry. Rigid quality control is maintained from ore to finished product.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



© 1956 Lone Star Steel Company

Lone Star STEEL COMPANY

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas
DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

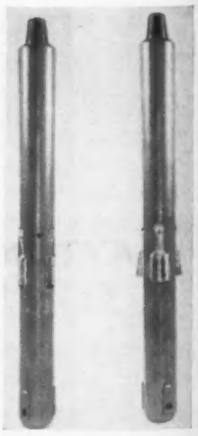
Bottom-Hole Assembly

A bottom-hole assembly for hydraulic free pump installations has been made available. It has a cone shaped landing-head made integral with standing valve shoe to permit running and landing the parallel string independently of main string. Features include: pressure balanced type seal combined with spring type lock which requires no rotation or other special actuation for seating or unseating. Bottom-hole assembly has "tub" type gas anchor with extremely high gas separating capacity. Lock is provided only as a convenience in landing and space-out, since no amount of hydraulic pressure will unseat the balanced seals. (Fluid Packed Pump Co. Supplements data on Pages 1761-1812, 1958-1959 Composite Catalog.)

For more data, circle E9 on postcard

New Section Mill

A new section mill that mills at the rate of 2 or 4 feet per hour on N-80, S-95 and P-110 casing is now available for field use. The mill will mill the standard 25 to 30-foot windows used for sidetracking operations in one trip into the hole. Cutting wings are raised to milling position by pump pressure and casing collars can be located easily. Each blade is dressed with a fragmented tungsten carbide cutting material, "Zitco," suspended in relatively soft matrix that absorbs shock. (A-Z International Tool Company).



For more data, circle E10 on postcard

W-K-M's NEW *Pressure Sealing* GATE VALVE

ASA 150 lb. (275 cwp)
and ASA 300 lb. (720 cwp)

The Seats are the

SECRET!

Approved for many services including:

air • gas • water • butane/propane gasoline • kerosene • alipathic alcohols aliphatic hydrocarbons • animal and vegetable oils • crude oils • naphtha • glycerol ethylene glycol.

Line Pressure Seals the Seats

The seats — made of specially formulated rubber molded to a hardened steel insert — are the secret to the valve's tight sealing performance. As line pressure in the valve increases, these unique seats actually float with the pressure to seal tightest where the most pressure is exerted.

Important Safety Feature

Excessive body pressure caused by thermal expansion is automatically relieved. The upstream seat is forced away from the gate by the excess pressure, allowing it to bleed into the line.

Change Seats in Minutes—on the line

You can change seats in W-K-M's Pressure Sealing Gate Valve (2" through 12") in 15 to 30 minutes . . . *on the line.* The only tools needed are a wrench and a pair of pliers.

Full Bore, Through-Conduit

Full bore, through-conduit gate construction permits a smooth flow with no more turbulence or pressure drop than through an equal length of pipe. The seats are fully protected from abrasive action of the lading flow.

Available Now

This versatile valve is available at leading supply stores everywhere. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

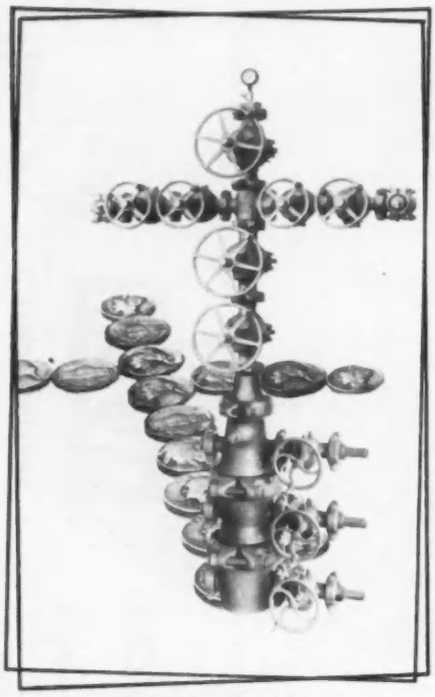
ANOTHER OUTSTANDING PRODUCT OF W-K-M's *Creative Engineering*

Write for Catalog 1200

W-K-M Division of ACF Industries, Incorporated
P. O. Box 2117, Houston, Texas

W-K-M
SERVING INDUSTRY 40 YEARS

5909



GRAY

Well Control Means Safety is Economy

How much is safety worth on your well?

. . . In insurance?
. . . In accidents?
. . . In down time?
. . . In loss of production?
. . . In repairs?

The degree of safety you want for your well is your problem. But if you want maximum safety Gray Systems of Well Control will be your answer.

Design, engineering, construction, all are based on safety. Pressure areas are reduced to a minimum. Maximum flexibility is built into the assembly to provide for positive, efficient handling of every well control problem.

In any pay zone . . . deep or shallow, single or multiple . . . you can rely on Gray Systems of Well Control to give you practical, economical well control safety.

For more information about the economics of Gray Well Control safety, contact your nearest Gray Tool representative. His telephone number is on the back cover of the Gray Catalog in Composite Catalog.

Safety is Economy

GRAY Tool Company

P. O. BOX 2291 HOUSTON, TEXAS
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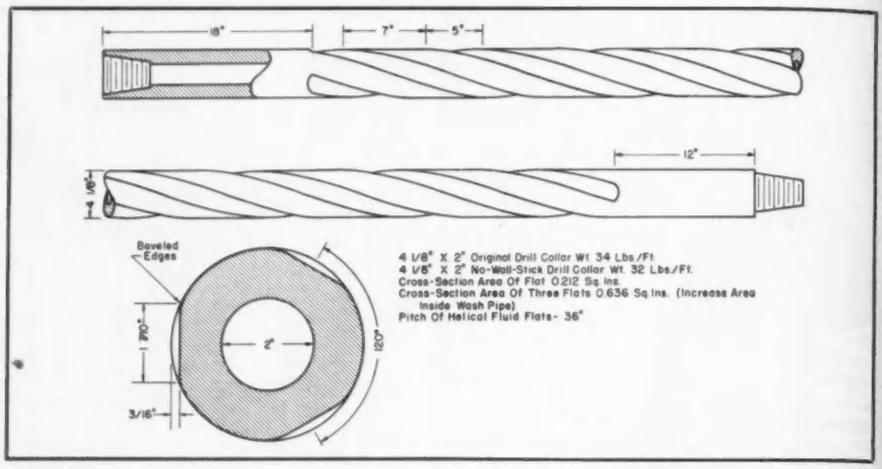

18"
7"
5"
12"
Beveled Edges
3/16"
120°
4 1/8" X 2" Original Drill Collar Wt. 34 Lbs./Ft.
4 1/8" X 2" No-Wall-Stick Drill Collar Wt. 32 Lbs./Ft.
Cross-Section Area Of Flat 0.212 Sq. Ins.
Cross-Section Area Of Three Flats 0.636 Sq. Ins. (Increase Area Inside Wash Pipe)
Pitch Of Helical Fluid Flats- 36"

New Spiral Drill Collar

A new basic design for drill collars has been developed for use where very large drill collars are being run and in deep or directional holes where stabilizers are presently being run to prevent wall sticking. The design consists of spiraling several small flat surfaces or convex surfaces over almost the complete length of the drill collars outside surface. This design reduces the area of wall contact between the drill collars body and formation by approximately 40 percent. The fluid flats are shallow and the weight loss is slight. These fluid flats can be machined on any size of drill collars. At present they are being built in small sizes for rental in the Texas and Gulf Coast areas under the name of NO-WALL-STICK drill collars. (Fred K. Fox)

For more data, circle E11 on postcard

Lighted Winker Buoy

A 3-foot fiber reinforced plastic buoy with winker lighting equipment is now available. All types of marking duty are well within the buoy's capacity and it is especially useful for indicating mooring limits, channels and obstructions. Corrosion is completely absent, according to the manufacturer, no painting is required and damage can always be repaired are a few of the advantages of glass reinforced plastic material used in making the buoy. (Chance-Londex Limited).

For more data, circle E12 on postcard

Dual Trailer Drilling Mast

A new 97-foot free standing telescoping mast, designed to handle full rated hook load capacity and withstand 75 mph wind load with full setback of pipe without guying has been introduced. Mast trailer is constructed so that in drilling position it provides a 4-foot wide kelley slide and 3-foot, 6-inch high walkway to pipe racks. Reel has a capacity of 1,800 linear feet of 1-inch wire line and is powered by a 9.2 horsepower gasoline engine. (Continental Emsco Co., Division of Youngstown Sheet & Tube Co. Supplements data on Page 1437, 1958-1959 Composite Catalog).

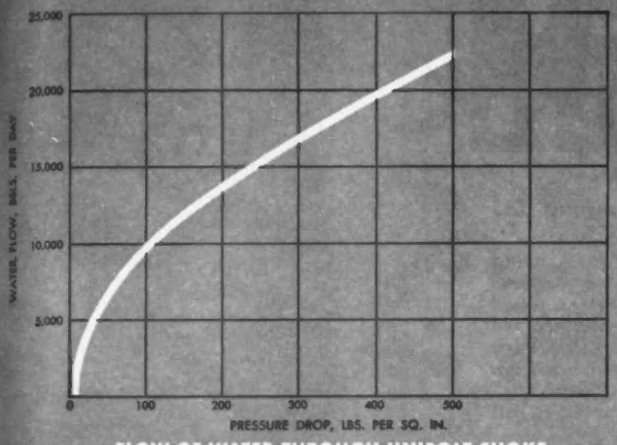
For more data, circle E13 on postcard

Automatic Programing

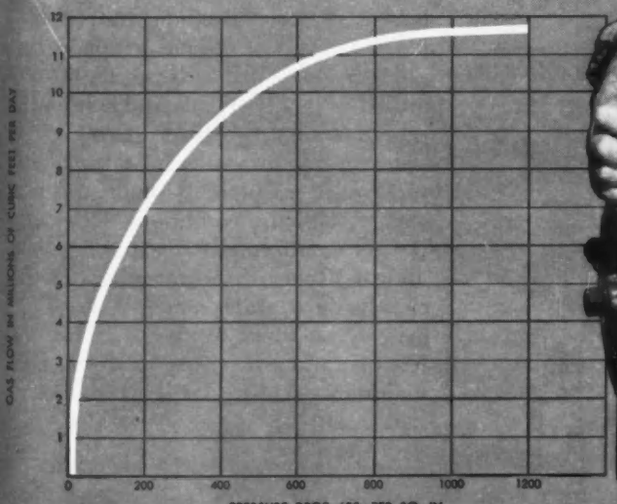
A completely automatic system for programing and recording oil well production and tests is now available. Equipment automatically schedules production and test well routines as well as LACT operations. Programing equipment also automatically transfers well production from test to group manifolds as required, or shuts down wells during emergencies. Components of the new POR (Production Operations Recorder) System vary according to the needs of the individual producer. (Fischer & Porter Company.)

For more data, circle E14 on postcard

Flow area thru UNIBOLT ADJUSTABLE WING VALVE
Passes Large Quantities of Fluid or Gas



FLOW OF WATER THROUGH UNIBOLT CHOKE WITH 1" SEAT



FLOW OF GAS THROUGH UNIBOLT CHOKE WITH ½" SEAT AT 2000 PSI INLET PRESSURE

if you could produce 10,000 bbls. per well per day . . .

. . . as the charts show, this UNIBOLT Adjustable Wing Valve would handle the fluid with only a 100-lb. pressure drop! Or, you could produce 28 million cubic feet of gas through it with only a 200-lb. pressure drop. So, while the UNIBOLT Adjustable Wing Valve is not a full-opening type, its one-inch flow area is far more than adequate for practically any desired production rate—*and the cost is importantly lower than for conventional gate and plug valves.*

Actually, there's a dozen more good reasons why this UNIBOLT Adjustable Wing Valve is a solid favorite among value-conscious operators:

1. There are no exposed threads . . . no accidental damage.
2. All metal seats . . . not affected by high or low temperature.
3. Stem packing that needs no tightening.
4. Stem turns freely under high pressures.
5. Threads on stem not exposed to external or internal damage.
6. Full 2½" pilot for true stem alignment and rigidity.
7. Streamlined flow—no obstruction, no turbulence or impingement of flow, no negative pressure areas.
8. Requires no grease to effect a seal . . . may also be used as micrometer-gauged flow bean.
9. Variable choke speeds up initial clean-up or running initial flow tests . . . saves rig time.
10. Can be converted to "Pressurematic Safety Valve" by simply changing bonnet assemblies.
11. Valve can be completely overhauled without removal from tree.
12. Stem seat sealed by metal gasket; power threads assure alignment.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

slim hole EQUIPMENT

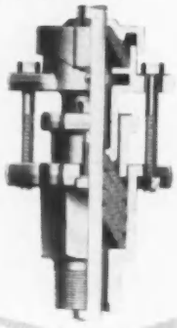
FIRST from HERCULES

HERCULES is First to provide a complete line of equipment for this new Oil Production Technique.

The use of 2½" tubing for casing and 1¼" or 1½" tubing as the oil string has made it necessary to develop new equipment specifically for this purpose. In response to the requests of production men, Hercules now provides tested and proven production equipment for Slim Hole Drilling. The well-known Hercules "Tee-Type" Duplex Stuffing Box and the new 2½" Hercules Type "HF" Tubing Head are incorporated in this typical Slim Hole well hook-up. Hercules "Tee-Type" Duplex Stuffing Box is now available in 1¼" and 1½" tubing sizes (plain or EUE) with the same packing and parts used in all Hercules Duplex Stuffing Boxes.

HERCULES "TEE TYPE" DUPLEX STUFFING BOX A combination Tee and Stuffing Box with female thread to screw directly onto the 1¼" or 1½" tubing, eliminating one-threaded connection and resulting in a considerably shorter hook-up. 3000 PSI test. Approximate height 15". Weight 33#. Price $31.00.

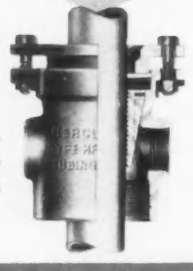
HERCULES TYPE "HF" SLIM HOLE TUBING HEAD Features the safety and quality that you receive in all Hercules tubing heads at a minimum price. Pressure cast, one piece steel body with 2" side outlets and heat-treated hinged slips. Over-head packed with neoprene packing. 1000 PSI test. Height 8½". Weight 19#. Price $49.50.



HERCULES "REGULAR TYPE" DUPLEX STUFFING BOX Proven design and dependability render this stuffing box unequalled for the difficult pumping situations as well as easy ones. Constructed from malleable iron, it protects workers from the danger of shattered metals should rods accidentally drop. The new 1¼" or 1½" "Regular Type" Stuffing Box is ideal for use in Slim Hole installations.

HERCULES TYPE "DS" PUMPING TEES In the 1¼" and 1½" sizes these Tees are ideal for use on Slim Hole well hook-ups.

HERCULES TYPE "HF" TUBING HEAD In spite of its economical price, the Type "HF" Tubing Head is pressure cast with one piece cast body and Overhead Packed with neoprene Packing Ring. This Head is now available for 2" or 2½" Tubing to suspend ¾" to 1½" Inner String (Plain or EUE) for Slim Hole operations.



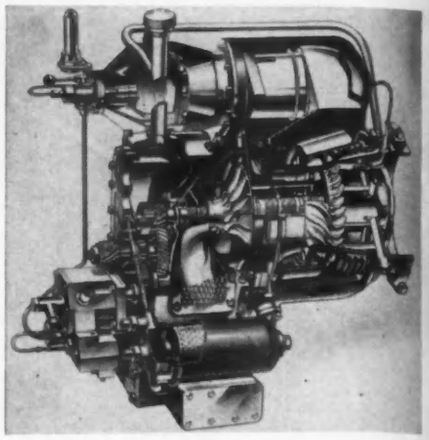
All Hercules Products for Slim Hole Drilling may be purchased through the supply store of your choice. Write for complete information.

HERCULES TOOL COMPANY

Manufacturers of Oil Field Equipment

GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA

Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.



Industrial Gas Turbine

A fully developed single shaft engine having a continuous output rating of 60 bhp at normal temperatures and pressures is the Rover IS/60 engine. For both portable and stationary requirements, the Rover IS/60 offers reliability, lightness, easy starting and full power availability under widely varying climatic conditions. Lubricating oil consumption is extremely low and the Rover IS/60 can operate efficiently on a wide range of distillate or gaseous fuels. With its vibrationless operation, it is easy to install and maintain. (Rover Gas Turbines Limited).

For more data, circle E15 on postcard

New Filter Programer

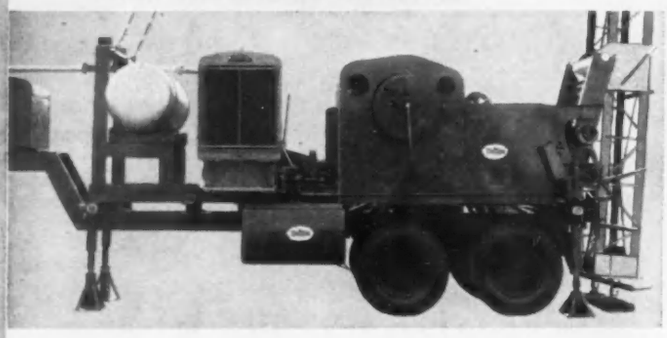
Designed to save water, power, labor and to remove the human error in backwashing filters is the National BFP-100 programer. The programer is a rugged industrial electrical control and is actuated by a differential pressure switch which senses the difference in pressure across the filter bed. The length of backwash is readily changed by changing the programer timer. It operates on 110 VAC, 60 cycles. Supplied in weather-

...Look for it First in...

Composite Catalog

For more than a generation, COMPOSITE CATALOG has been helping to simplify oil field procurement problems in the field or at the office. In the current edition you'll find detailed information on more than 3,000 oil field products and services—the most useful and complete COMPOSITE CATALOG ever published.

9,000-FT. SERVICE UNIT . . . 8 FEET WIDE



WICHTEX Model F-75-Heavy-Duty . . . truck or trailer mounted . . . is recommended to 9000 feet with an 87-foot or 65-foot fabricated telescoping derrick, or double telescoping 65′ x 7″ x 8″ mast, or double telescoping 87′ x 8″ x 10″ mast. Equipped with air friction clutches, air or hydraulic friction cathead, and winch mounted to raise mast. Write for specifications:

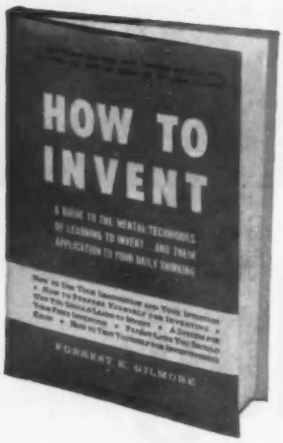
Wichtex WELL SERVICING UNITS

WICHTEX MACHINERY COMPANY

P.O. Box 2250 **WICHITA FALLS, TEXAS**

Manufacturers of Wichtex Servicing Units (2000′ to 12,000′ capacity) and Wichtex Portable Rotary Rigs (2,000′ to 5,000′ capacity).

Just Because You Have Never Invented Anything Does Not Mean You Have No Talent For It.



HOW TO INVENT

By Forrest E. Gilmore

Price $2.50

A guide to the mental techniques of learning to invent . . . and their application to your daily thinking.

In easy-to-read and understand language this book shows you: how to use your intuition and imagination, how to prepare for invention, how to test your Ingenuity Quotient, when and where to invent, how to find time to invent, ways to profit from your invention, how to record your observations, why some potential inventors fail.

The book also contains a detailed discussion of patent practices you should know such as: how to decide what is patentable, how to go about obtaining a patent, what a patent really means, how to protect your patent from the beginning.

Order from your bookstore, or:

Book Department
Gulf Publishing Company
P. O. Box 2608, Houston 1, Texas

proof, dust-tight housing for wall mounting. (National Tank Co. Supplements data on Pages 3669-3688, 1958-1959 Composite Catalog).

For more data, circle E16 on postcard

Literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL

Automatic Drilling Control

A new illustrated bulletin from The National Supply Company tells how the new National Model No. 6 Micromatic drilling control operates and points out advantages.

To get a copy, circle E17 on postcard

Diacel Cement Systems

Drilling Specialties Company of Phillips Petroleum Corporation, presents a 38-page Technical Data Booklet on the applications of Diacel cement systems. It contains tables and data on the application of Diacel D low-density cements and the Diacel LWL retarder and low water loss cement additive.

To get a copy, circle E18 on postcard

Dresser Guidebook

"World-Wide Guide to Dresser Equipment and Technical Services" is a 68-page illustrated book and provides references to products and services supplied by the Dresser companies all over the world. Lists of representatives and addresses are also included.

To get a copy, circle E19 on postcard

Wayne Hand Pumps

Four new 4-page brochures and two, 2-page units describe the complete line of internal gear rotary pumps offered by the Wayne Pump Company, Division of Symington Wayne Corporation. Also contains description, opinions and details of the pumps.

To get a copy, circle E20 on postcard

Water Treatment Bulletin

Issued by Process Engineers, Inc., Division of The Eimco Corporation, Bulletin SM-1013 features the Reactor-Clarifier, an Eimco-Process development which combines coagulation and flocculation, sedimentation and sludge removal in a single unit.

To get a copy, circle E21 on postcard

REFERENCE

- OIL FIELD
- GAS FIELD
- OIL PIPE LINE
- PROPOSED OIL PIPE LINE
- GAS PIPE LINE
- PROPOSED GAS PIPE LINE
- PRODUCTS LINE
- PROPOSED PRODUCTS LINE
- (R) REFINERY
- (G) GAS PROCESSING PLANT
- (P) PETROCHEMICAL PLANT

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BLUEBERRY
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HALFWAY
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Pt. St.
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SUNRISE
POUCE COUPE SOUTH
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R.
Parsnip River
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Tp. 112

29th Base Line

RIVER

Lake Claire

28th Base Line

Birch

R

PADDY

Chinchaga

110

105

27th Base Line

MERIDIAN

100

Mikkwa

26th Base Line

R

Wabiskaw

95

25th Base Line

FIFTH

ATHABASKA
BITUMI
SA

CLEAR HILLS

90

24th Base Line

River

BRIDGEVILLE

RED EARTH CRK

23rd Base Line

THREE CREEKS

85

R

UCE COUPE

WHITELAW

Peace River

22nd Base Line

PEACE

DUNVEGAN

TANGENT

SPRINGBURN

Gordondale

80

NORMANDVILLE

BELLOY

21st Base Line

SPIRIT RIVER

EAGLESHAM

GROUARD

COUPE
UTH

10

ROCROST

SADDLE HILLS

1

HEART R.

SMOKY R.

IROQUOIS

75

20th Base Line

River

HIGH PRAIRIE

Lesser Slave Lake

25

ELWOOD

Grande Prairie

STURGEON LKE

20

WEST PRAIRIE

10

5

Slave Lake

River

CAMPBELL CRK

70

GROVEDALE

STURGEON L. SOUTH

BIG MTN.

70

WESTERN CANA

OIL & GAS FIELDS

MILES 25 0 25 50 75 100 MILES

RIVER

Tp. 117
Tp. 116

LAKE ATHABASKA

29th Base Line

RIVER

Lake Claire

28th Base Line

R

Birch

27th Base Line

MERIDIAN

Mikkwo

26th Base Line

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25th Base Line

FIFTH

ATHABASKA 95
BITUMINOUS
SANDS AREA
90
85

River

RED EARTH CRK

23rd Base Line

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22nd Base Line

21st Base Line

80

Base Line

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Steve Lake

70

SIMONETTE

SIXTH MERIDIAN

BERLAND R

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Lake

Peter Pond Lake

Lac Ille a la Cross

BIG MTN.

NADA

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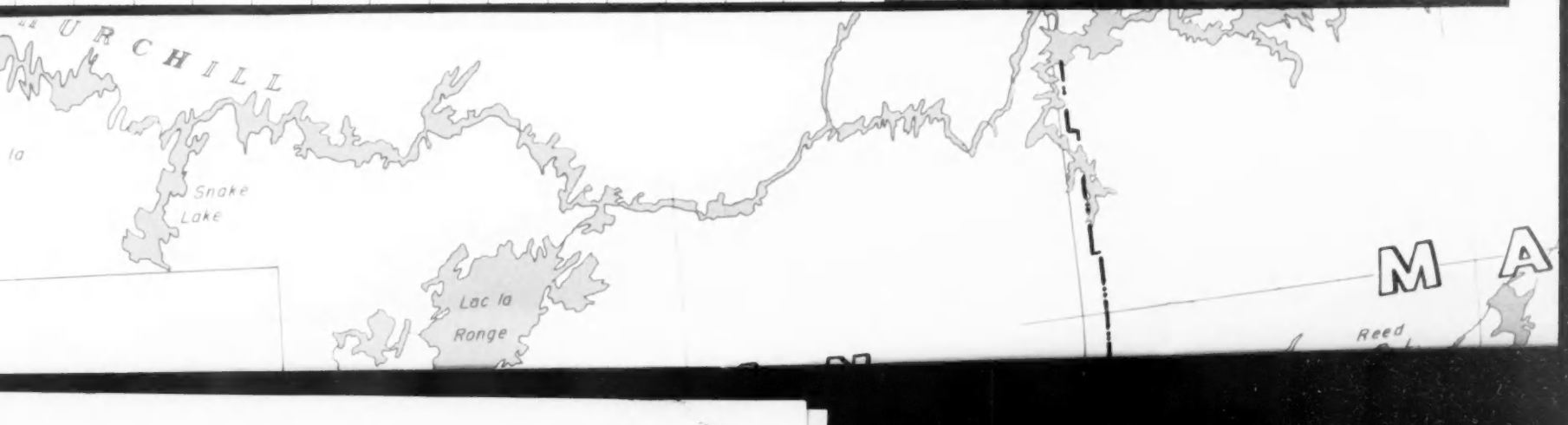
STURGEON LAKE–PEMBINA INSERT



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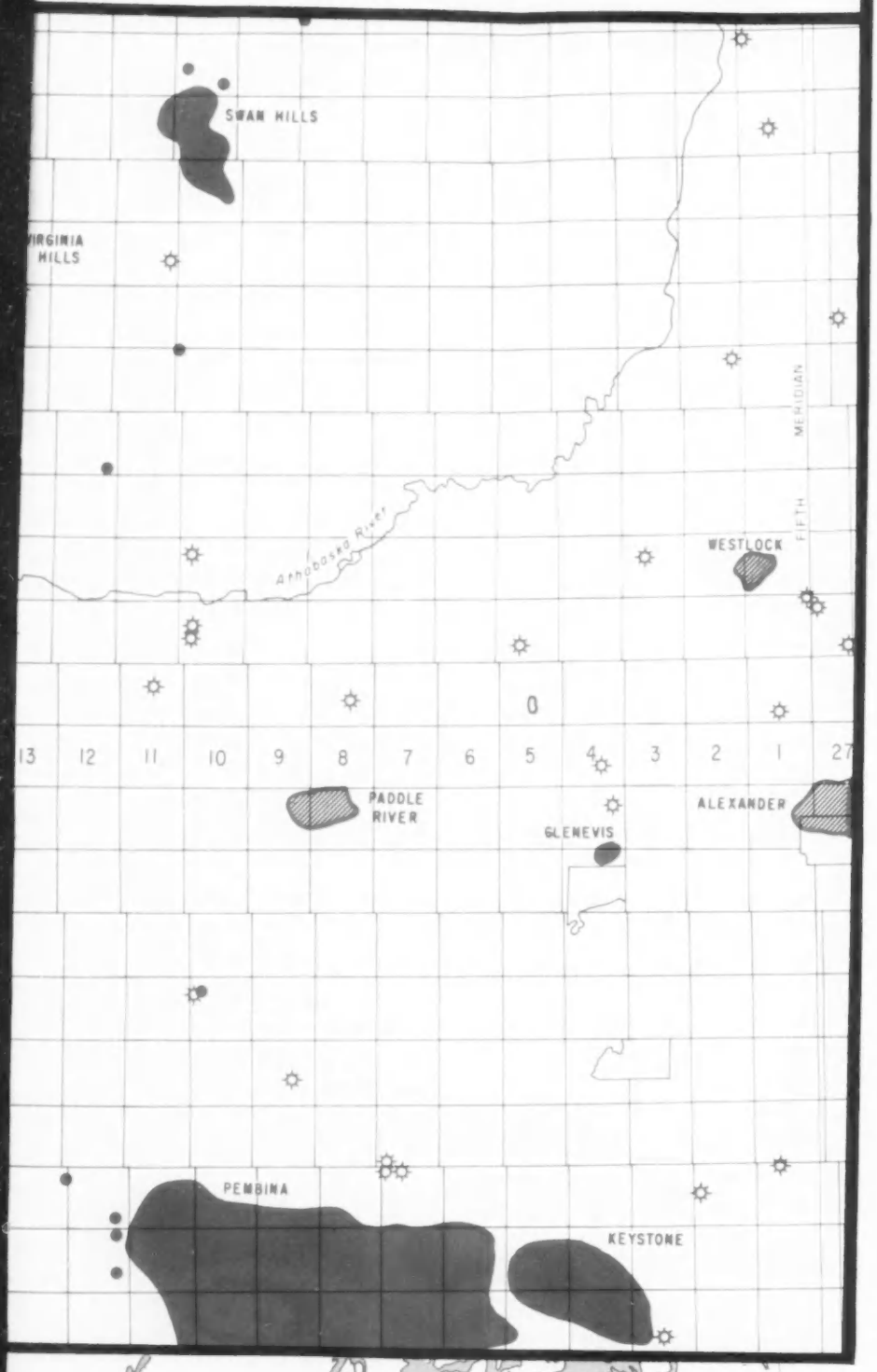

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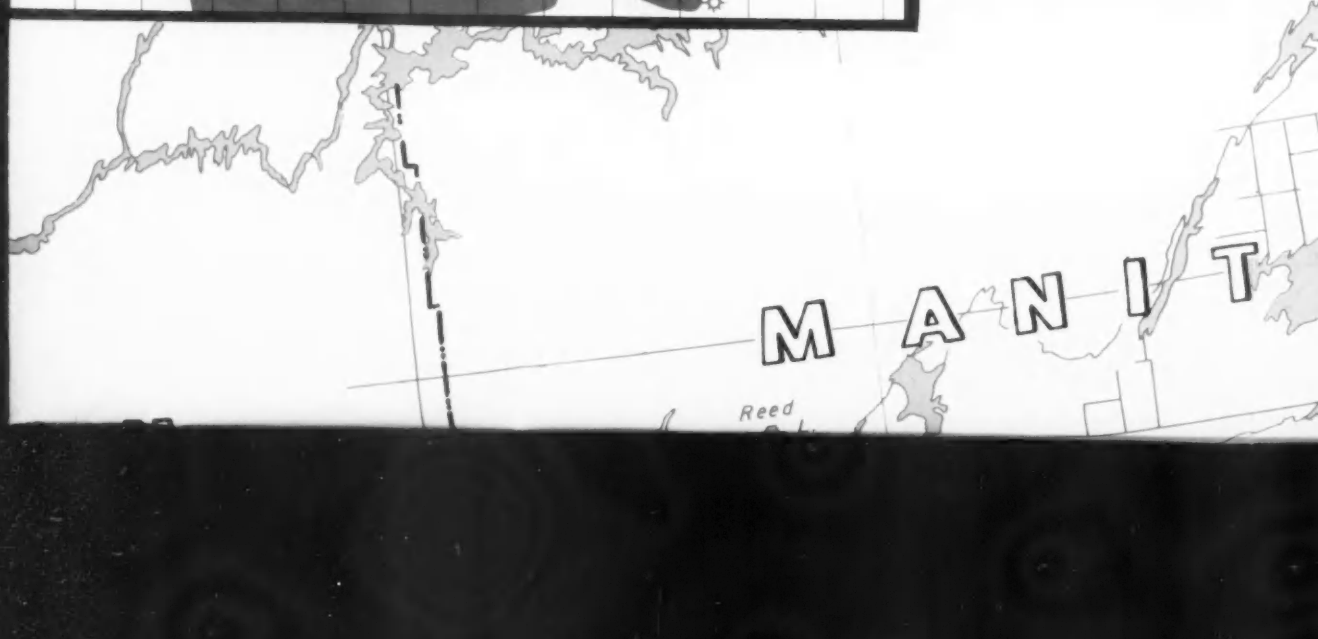

Ronge

E. BRITISH COLUMBIA INSERT

FORT NELSON

T NELSON

94 I

PADDY RIVER

94H

BEATTON RIVER

BIG CREEK

ALASKA HIGHWAY

GUNDY CREEK

BLUEBERRY

BUICK CREEK

88

KOBES

25

24

HALFWAY

23

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RED CREEK

BOUNDARY LAKE

85

84

FORT ST. JOHN

Utik L.

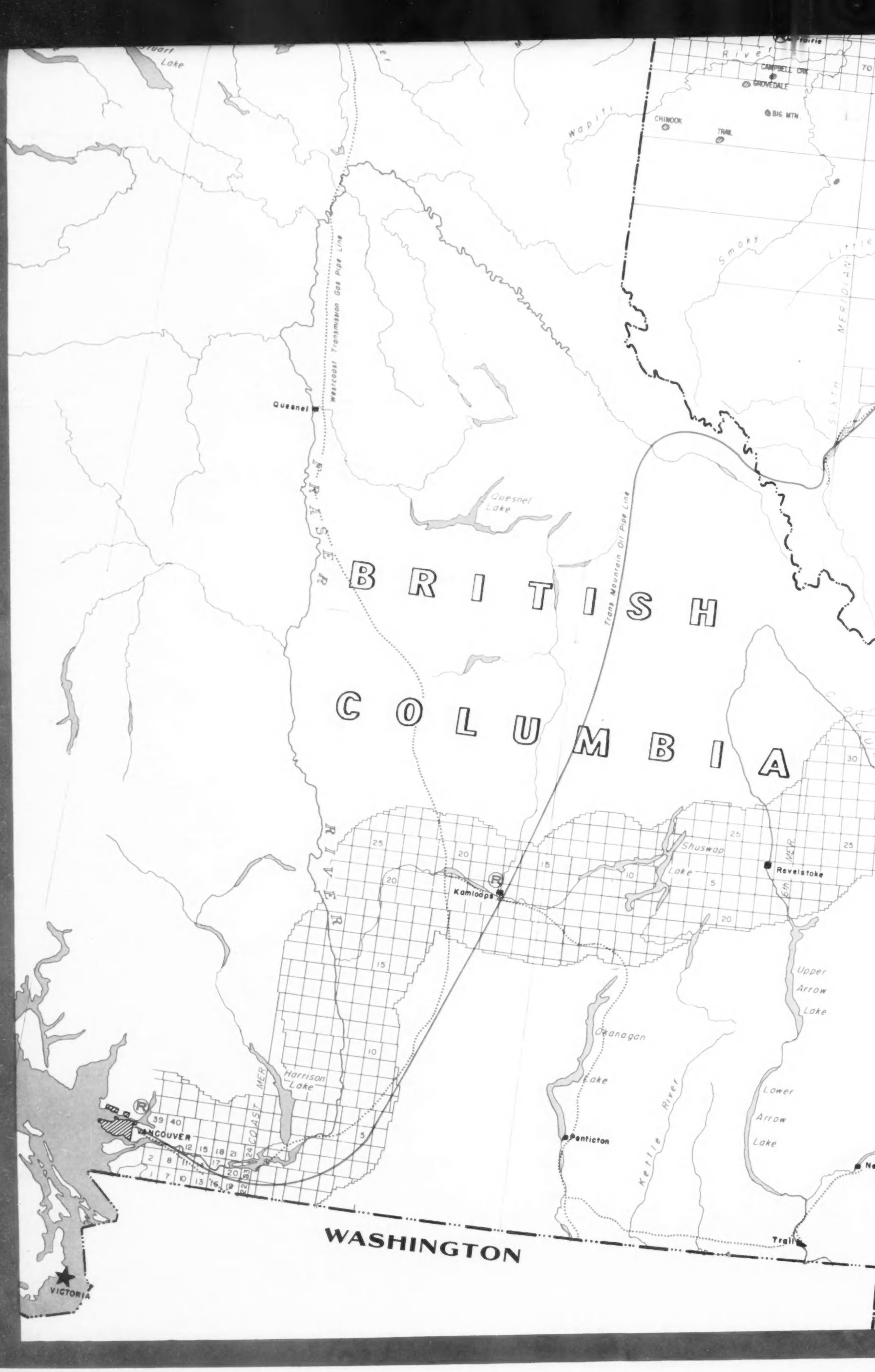
Knee Lake

Sipiwesk Lake

Gods Lake

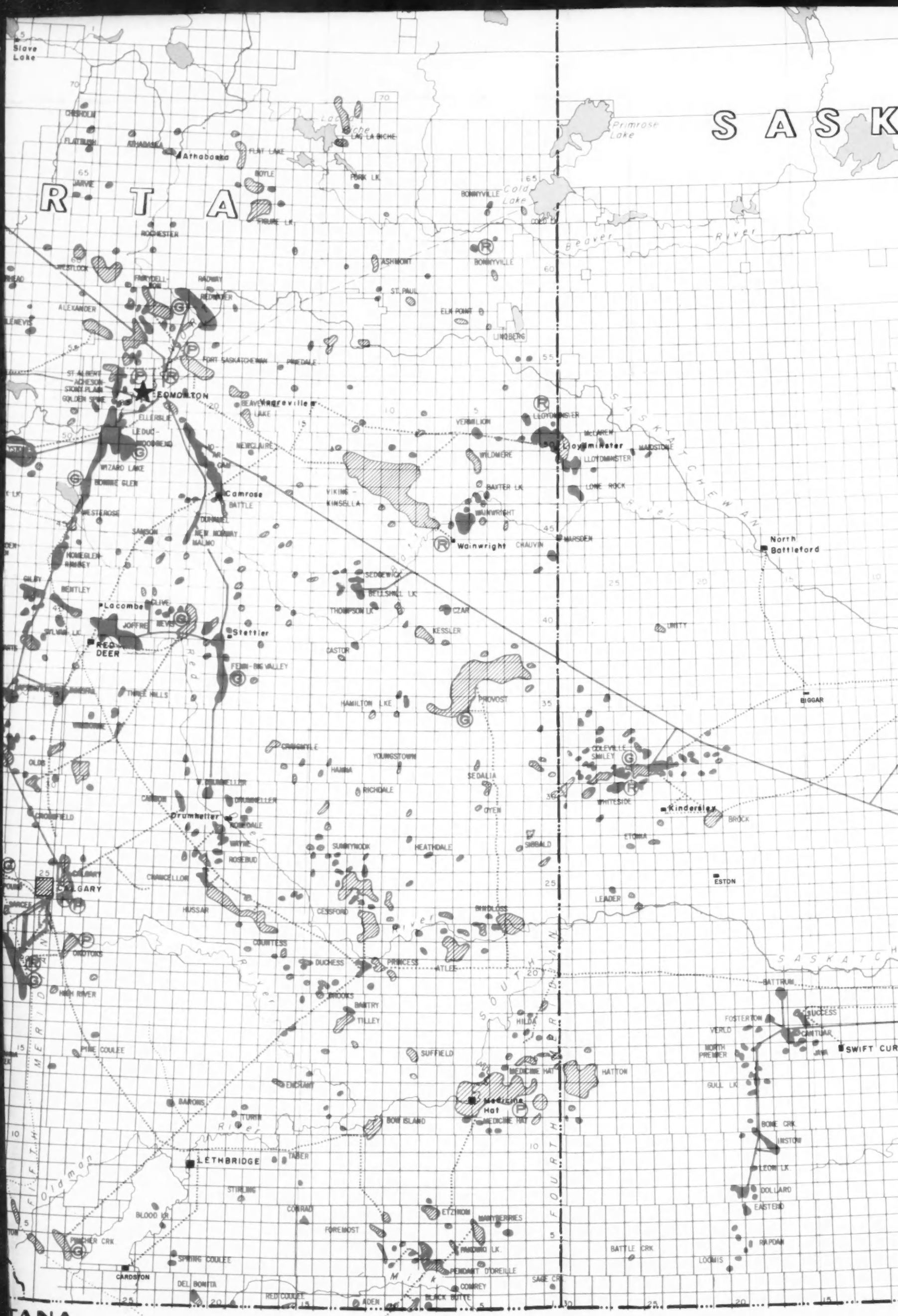
Oxford Lake

T O B A


Stuart Lake
Nechako River
Westcoast Transmission Gas Pipe Line
Quesnel
FRASER RIVER
Quesnel Lake
Trans Mountain Oil Pipe Line
Peace River
CAMPBELL CR.
GROVEDALE
CHINOOK
TRAIL
BIG MTN.
Wapiti
Smoky
Little
6th MER.
BRITISH COLUMBIA
Shuswap Lake
Revelstoke
Kamloops
Upper Arrow Lake
Okanagan Lake
Kettle River
Lower Arrow Lake
Penticton
Harrison Lake
COAST MER.
VANCOUVER
VICTORIA
WASHINGTON

ALBERTA

Slave Lake
STURGEON L. SOUTH
SWAN HILLS
VIRGINIA HILLS
W. GIROUX L.
SIMONETTE
JAYBOB
WHITECOURT
WINDFALL
PINE CRK
BERLAND R.
BEAVER CREEK
OBED
BLUERIDGE
BARRHEAD
PADDLE R.
GLENEVIS
ALEXANDER
CHIP LKE
WESTLOCK
ROCHESTER
FLATBUSH
ATHABASCA
Athabasca
FLAT LAKE
LAC LA BICHE
BOYLE
JARVIE
FIGURE LK.
PORK LK.
ASHMONT
ST. PAUL
RADWAY
REDWATER
FAIRYDELL-BON ACCORD
FORT SASKATCHEWAN
PINEDALE
ST. ALBERT
ACHESON
STONY PLAIN
GOLDEN SPIKE
EDMONTON
Vegreville
BEAVER LAKE
ELLERSLIE
LEDUC-WOODBEND
NEWCLAIRE
WIZARD LAKE
BONNIE GLEN
PEMBINA
MOUNTAIN PARK
LOVETT R.
BUCK LK.
ALDER FLATS
WESTEROSE
Camrose
BATTLE
VIKING - KINSELLA
DURNESS
SAMSON
NEW NORWAY
MALMO
ROCKY MTN. HOUSE
WILLESDEN GREEN
STOLBERG
Brazeau
HOMEGLEN-RIMBEY
ALHAMBRA
GILBY
BENTLEY
CRIMSON LK.
LEAFLAND
FERRIER
Lacombe
CLIVE
JOFFRE
NEVIS
SYLVAN LK.
RED DEER
EVARTS
Stettler
SEDGEWICK
BELLSHILL LK.
THOMPSON LK.
KESSLER
CASTOR
FENN-BIG VALLEY
THREE HILLS
HAMILTON LK.
SUNDRE
WESTWARD HO
HARMATTAN
EULTON
PANTHER R.
OLDS
WINCHELL COULEE
CROSSFIELD
WILDCAT HILLS
BANFF
JUMPING POUND
CALGARY
BARONS
CROSSLEE
YOUNGSTOWN
HANNA
RICHDALE
CARBON
DRUMHELLER
Drumheller
ROSEDALE
WAYNE
ROSEBUD
SUNNYNOOK
HEATHDALE
CHANCELLOR
HUSSAR
CESSFORD
COUNTESS
DUCHESS
PRINCESS
ATLEE
TURNER VALLEY
OKOTOKS
HIGH RIVER
BROOKS
BANTRY
TILLEY
SUFFIELD
PINE COULEE
ENCHANT
TURIN
BOW ISLAND
LETHBRIDGE
TABER
STIRLING
COALDALE
FOREMOST
WATERTON
PINCHER CRK
SPRING COULEE
CARDSTON
DEL BONITA
Kootenay Lake
Nelson
Fernie
KOOTENAY RIVER
IDAHO
MONTANA


Slave Lake
CHISHOLM
FLATBUSH
ATHABASCA
Athabasca
FLAT LAKE
LAC LA BICHE
Primrose Lake
SASK
R T A
BOYLE
JARVIE
PORK LK.
BONNYVILLE
Cold Lake
ROCHESTER
FIGURE LK.
Beaver River
ASHMONT
ST. PAUL
ELK POINT
LINDBERG
WESTLOCK
FAIRYDELL
RADWAY
REDWATER
ALEXANDER
FORT SASKATCHEWAN
FRIEDSDALE
ST. ALBERT
ACHESON
STONY PLAIN
GOLDEN SPIKE
EDMONTON
BEAVERHILL LAKE
Vegreville
VERMILION
Lloydminster
McLAREN
WILDMERE
LLOYDMINSTER
MANDSTONE
ELLERSLIE
LEDUC
DEVON
NISKU
WIZARD LAKE
BONNIE GLEN
BAXTER LK.
LONE ROCK
VIKING
KINSELLA
Camrose
BATTLE
WAINWRIGHT
CROSSFIELD
SAMSON
DUNMORE
NEW NORWAY
MALMO
Wainwright
CHAUVIN
MARSDEN
North Battleford
HOMEGLEN RIMBEY
SEDGEWICK
BELLSHILL LK.
GALAHAD
BENTLEY
Lacombe
OLIVE
JOFFRE
THOMPSON LK.
CZAR
UNITY
STYLVAN LK.
Stettler
RED DEER
KESSLER
CASTOR
FENN-BIG VALLEY
THREE HILLS
HAMILTON LKE
PROVOST
BIGGAR
CREMONA
YOUNGSTOWN
OLDS
HANNA
SEDALIA
RICHDALE
CARBON
DRUMHELLER
Drumheller
COLEVILLE
SMILEY
WHITESIDE
Kindersley
BROCK
CROSSFIELD
WAYNE
ROSEBUD
OYEN
SUNNYNOOK
HEATHDALE
SIBBALD
ETOMAMI
CHANCELLOR
CALGARY
ESTON
LEADER
HUSSAR
CESSFORD
BINDLOSS
COUNTESS
DUCHESS
PRINCESS
ATLEE
OKOTOKS
BROOKS
BANTRY
TILLEY
HILDA
BATTRUM
FOSTERTON
SUCCESS
VERLO
CAMTHAR
NORTH PREMIER
SWIFT CUR
HIGH RIVER
PINE COULEE
SUFFIELD
MEDICINE HAT
HATTON
GULL LK.
ENCHANT
BARONS
TURIN
BOW ISLAND
BOWE CRK.
IRISTON
LETHBRIDGE
TABER
LEOMI LK.
DOLLARD
EASTEND
STIRLING
CONRAD
ETZIKOM
MAYBERRIES
BLOOD IR.
FOREMOST
RAPDAN
PINCHER CRK.
PAKOWKI LK.
BATTLE CRK.
LOOMIS
SPRING COULEE
PENDANT D'OREILLE
CARDSTON
DEL BONITA
COMREY
SAGE CR.
RED COULEE
ADEN
BLACK BUTTE
FIFTH MERIDIAN
FOURTH MERIDIAN
SOUTH SASKATCHEWAN River
Milk River
TANA

SKATCHEWAN

M

Lac la Ronge

Reed L.

Montreal Lake

Moose Lake

RIVER

Cumberland Lake

SASKATCHEWAN

Prince Albert

Tisdale

RIVER

RIVER

HUMBOLDT

SASKATOON

Quill Lakes

Watrous

Interprovincial Oil Pipe Line

Qu'Appelle River

REGINA

MOOSE JAW

Trans Canada Gas Pipeline

SWIFT CURRENT

THIRD MERIDIAN

SECOND MERIDIAN

ASSINIBOIA

KAMSACK

ROCANVILLE

WAPELLA

KIRKELLA

MOOSE VALLEY

FLEETWOOD

PARKMAN

MOOSE MTN.

MANOR

WEST BUTLER

DALY

ERROR

MALBASTE MIDALE BENSON

WILLMAR

QUEEDIDALE

ALTIDA

THUSTON

WEYBURN

STEELMAN

NORTH RONCOTT

WILLMETA

CARNDUFF

GAINSBOROUGH

GLENEWEN

PINTO

Souris

NORTH

MANITOBA
Reed L.
Moose Lake
Playgreen Lake
RIVER
Cumberland Lake
SASKATCHEWAN
Cedar Lake
LAKE WINNIPEGOSIS
Dauphin
Dauphin Lake
KAMSACK
Trans Canada Gas Pipeline
WAPELLA
ROCANVILLE
KIRKELLA
NORTH VIRDEN - SCALLION
BRANDON
MOOSE VALLEY
FLEETWOOD
Virden
VIRDEN - ROSELEA
DALY
ROUTLEDGE
MAPLES
WEST BUTLER
BIRDIE
MOODIMORTH
MOOSE MTN.
MANOR
ALIDA
TILSTON
MELBOURNE
MIDALE
BENSON
WILLMAR
QUEENSDALE
WEYBURN
STEELMAN
MARIEVAL
WESTBISS
NORTHGROVE
PIERSON
SOUTH REGENT
WHITEWATER
CARNDUFF
GLENCAIRN
PINTO
GAINSBOROUGH
CAMERON
Souris River
ASSINIBOINE
NORTH DAKOTA

Molson Lake

Island

yareen Lake

A K E

WINNIPEG

Berens R.

LAKES

MANITOBA

25

20

15

10

5

1

30

10

5

1

5

10

15

MERIDIAN

PRINCIPAL

RED

WINNIPEG

Portage la Prairie

RIVER

RIVER